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PERSPECTIVE VIEW OF DOUBLE COTTAGE.—See page 80.

RURAL ARCHITECTURE;

BEING

A SERIES OF DESIGNS FOR RURAL AND OTHER DWELLINGS,

FROM

THE LABOURER'S COTTAGE TO THE SMALL VILLA AND FARM HOUSE

WITH OUT-BUILDINGS,

WITH DESCRIPTIONS OF THE PLANS, REMARKS ON THE MATERIALS USED IN THEIR CONSTRUCTION, AND DIRECTIONS FOR THE WORKMANSHIP.

LONDON:
ROGERSON AND TUXFORD, 246, STRAND.

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June 8, 1892

PREFACE

TO THE ORIGINAL EDITION.

The Handbook of Rural Architecture is intended to supply the readers, within its sphere of action, with information of a popular kind on the various points connected with house building; how, if they desire to build, they may provide themselves conveniently and economically with a well-drained, well-ventilated residence, suited to their circumstances; or, if they are about to purchase or rent, the information necessary to enable them to make a proper selection.

Subservient to this object, but still with the same economical views, the author has devoted his attention to a subject of great national importance—the question of cottages for rural labourers; in which the more benevolent and patriotic of our nobility and landed proprietors are now so much interested. It cannot be doubted that in doing so the right-minded noblemen and gentlemen who have taken the lead in this important matter are only fulfilling the duties attached to the possession of property and station; but it is impossible to overestimate the advantages, both in a moral, social, and sanitary sense, of their fulfilling those duties; nor is it possible to reprobate more than it deserves, the conduct of those who wilfully neglect them.

Note.—The Ground Plans, Elevations, and Specifications, are by James Sanderson, Borough Engineer's Office, Liverpool.

PREFACE.

THE early edition of this little work was received with the most favourable success, and accepted by the public as a "HANDBOOK OF RURAL ARCHITECTURE."

In an unpretending and economical form, this little treatise was found to contain practical and most valuable information. A large edition was therefore rapidly exhausted; and a constantly-increasing demand having since arisen, has induced the publishers to issue the present edition.

Every care has been taken to maintain the high character already won. The work has been revised by Mr. GEORGE MORGAN, Fellow of the Royal Institute of British Architects, who has contributed the additional paper upon "Labourers' Cottages," a subject scarcely entered upon in the earlier edition. In other respects, with the exception of some slight abridgment, this volume of THE HANDBOOK OF RURAL ARCHITECTURE embraces the whole of the matter contained in its predecessor.

NOTE.—The additional Plans and Specifications are those of THE COTTAGE IMPROVEMENT SOCIETY.

LONDON, *April*, 1860.

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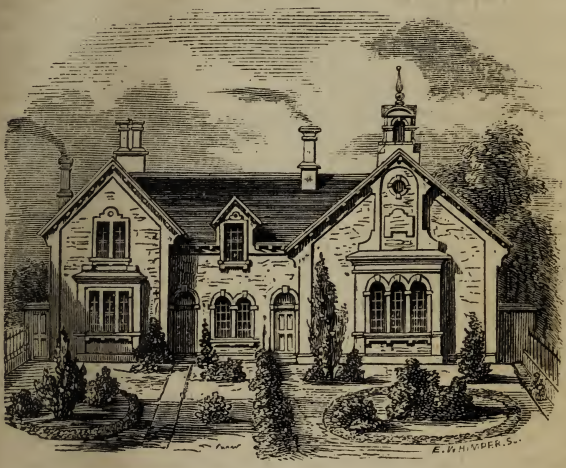
RURAL ARCHITECTURE.



CHAPTER I.

INTRODUCTION.

THIS little work has no pretension to a formal epitome of the science of architecture, but simply aims at being considered a repertory of hints, suggestions, and facts. The book is simply addressed to a class who are daily increasing in number and importance, whose general intelligence only requires a slight amount of technical knowledge to make it practically useful, and who have been hitherto only deterred from becoming so from a deficiency of the information which we are endeavouring to supply.

Before, however, we proceed to detail the practical application of architecture, we may, perhaps, be permitted to indulge in a few remarks upon the general subject, as there appears no little diversity of opinion upon some of its leading features.

The first aim of man in his structural efforts must, it is fair to assume, have been directed to *utility*—a principle which varies with all the accidental circumstances of climate and custom; and when even ornaments began to be an object of attention, his taste must have pursued the same track which utility had already marked out. To this circumstance may be attributed the distinct character which architecture has assumed in different countries, and which has enabled it to preserve, throughout its rise, progress, and decline, the peculiar forms which it originally received. The principle of utility, then, has been rarely sacrificed to that of ornament; and the main purpose of the structures of antiquity may be clearly traced, though beauty has occasionally stepped in to perplex "with her spiritual charms" its simple form. It was not, however, till utility had been secured, that other motives were suffered to intrude themselves, and the considerations of magnificence and beauty were admitted to have a share with those of convenience. Thus, what was at first calculated barely to supply the wants of mankind, became by degrees subservient to higher purposes, and even added a lustre to the most polished conditions of the world.

An art, however, which unites usefulness with beauty, and addresses itself to the wants as well as to the tastes of mankind, must naturally be influenced by their moral and physical habits, and by the varied modes of existence which mark their progress towards civilization. Under the influence of these peculiar combinations, a constant state of transition has been the essential condition of architecture as an art; and, both in ancient and modern times, it has frequently diverged from a common point of departure to the most distant extremes, and even into the most opposite principles of taste. Yet, throughout all these modifications the architecture of a country has generally preserved its leading forms, and the prime features of its character; and though there may be a wide difference between the most polished and the primitive structures of a people, as regards ornament and beauty, there is none in principle,—for the earliest temple of Greece, that of Apollo at Delphi, which Pausanias informs us resembled a hut or cabin, was as strictly the form of a geometric solid as the Parthenon at Athens, with all its exquisite finish, and its finely-proportioned parts.

In all ages of the world, then, of which we have any architectural remains, there may be traced a distinct character of art which sprang out of its physical necessities, its social relations, and its moral requirements; and when any one people has been the copyist of another—has merely contented itself with transferring its structural forms—there has invariably arisen an incongruity of purpose; for the idea of which the original is an outward and active representation is no longer present, but must give place to one that has little or no affinity with it. A Greek temple in form and structure, for example, is but ill-adapted to the peculiar worship of a Christian church; no more than a Hindoo temple is a fitting place for a Mahomedan to perform his rites in, or a mosque for the religious duties of a Hindoo. The structure is simply, in all ages and countries, the form in which the spirit of religion delights to take up its abode, and that form necessarily varies with the respective attributes of the soul, be it where it may, whether offering its orison to the "God of all castes and colours," or breathing a prayer to

"Jehovah, Jove, or Lord."

In all these cases, then, architecture ought to be a representation of the religious feeling, and, like true æsthetic art, simply an activity by means of which something internal or spiritual is revealed to sense.

With these few preparatory remarks upon the leading principles of architecture, and an occasional allusion to its grander illustrations in the remains of antiquity, we shall enlarge for a short space upon domestic architecture, and endeavour to trace its rise and progress in this country up to the present time.

Strictly speaking, there is little of what may be called domestic architecture before the time of Elizabeth, and even that little is confined to a limited circle, and to a highly privileged few. The creation of a middle class was the creation of domestic architecture. The benefits arising from a settled form of government, by which property was respected and legal right acknowledged, naturally excited a feeling of security amongst all classes of society, and made the domestic hearth the object of the greatest care and affection. The nobility, and even the humbler gentry, had begun to emerge from the gloom of the middle ages into the more cheerful comforts of modern life; their rude pastimes had given place to gentler amusements, and the rough mould of their minds had been fashioned to a smoother form, so that the character of their existence had undergone a complete and entire transformation. The habitations which were

erected at this period have become a familiar object of beauty in English landscapes, and the Elizabethan manor-house is still recognized as the orthodox standard of English architecture. The plan of building houses of this class, with two projecting wings and a porch in the middle, is so common, that it has been supposed to represent the letter E, and to be intended as a compliment to the maiden queen; and though this conceit may appear somewhat far-fetched, the style of structure is, nevertheless, in perfect accordance with the prevailing taste of that age.

Little more than a quarter of a century preceding the reign of Elizabeth, the domestic architecture of England was at a low ebb, and little comfort was enjoyed by the middle classes, or even by the classes much above them. In the time of Henry VIII., Erasmus, who visited this country, complains that the nastiness of the people was the cause of the frequent plagues that destroyed them; and he remarks, "that their floors are commonly of clay, strewed with rushes, under which lie unmolested a collection of beer, grease, fragments, bones, spittle, excrements of dogs and cats, and everything that is nauseous." The elder Scaliger, another scholar who came to England, abuses the people for giving him no convenience to wash his hands. Glass vessels were scarce, and pottery was almost wholly unknown. While such universal slovenliness prevailed as Erasmus has described, and as Scaliger hints at, it is not likely that much attention was paid to the structure of houses, or, indeed, to anything indicative of comparative comfort and cleanliness. The Spaniards, also, in the time of Philip II., bear indirect testimony to the meanness and poverty of our buildings at this period; for while they complimented us on our good living, they expressed a surprise that such excellent housekeeping should be found within the walls of mere "sticks and dirt."

At the time of which we write there was little done for comfort and convenience in our structures, as these were terms but little known and scarcely recognized in our domestic nomenclature. The great houses were scantily provided with living-rooms, when compared with the number of lodging apartments and offices. The facility of communication, so indispensable to the habits of modern life, was totally disregarded, and the open court was the only passage from one part of the building to the other. Down even to the farm-houses of the fifteenth century, of which several still remain in good preservation in some parts of England, the same system is to be traced. Two wings, joined by a central hall, with the entrance and

passage at the lower end, was the general and uniform plan of structure.

In the fifteenth century the internal fittings and decorations of houses—if the latter term may be applied to such a condition of things—were in a rude and uncultivated state, for neither wood-linings nor plaster ceilings were yet introduced. The tapestry, or hangings, which commonly prevailed at this period, were made subservient to use as well as to decoration; for, in addition to ornamenting the apartments, they had to obviate the defects of both ill-closed doors and of ill-fitting windows. Chimneys, it is true, had come into general use in the better order of buildings, though few rooms were provided with them; but in the great chamber, as it was commonly called, the chimney-piece was made subservient to decorative purposes, in many of which considerable taste and ingenuity were displayed. The armorial shields and devices of the family were generally engraven upon them.

One of the most interesting features, however, of this period, in connection with building, is the revival of the use of bricks. The style of domestic architecture immediately experienced a change, and ere the close of the century a complete revolution was effected in almost every branch of building. We are indebted to the Flemings for the introduction of the brick, and still preserve the form which they first introduced amongst us, although it is doubtful whether we ever lost the art of making that useful article. The manufacture of tiles was certainly never laid aside in this country, though bricks are of extreme rarity before the period we have just mentioned.

Little is known, however, of what may be termed our domestic architecture at this period. Fitzstephen has given us the earliest detailed description of an English town, but little can be gathered from him of general internal and domestic arrangements. We learn from his account, "that almost all the bishops, abbots, and great men had goodly houses (*ædificia præclara*) in London, to which they resorted, and where their disbursements and expenses were not sparing, whenever they were summoned from the country to attend councils." He tells us, also, that the "two great evils of London were drunkenness and the frequency of fires." To the latter fact all our early histories bear ample evidence; and, in order to obviate the evil, it was enacted, in the first year of Richard I., that the lower storey of all houses in the city of London should be built with stone, and the roofs covered with tiles or slates. This mode of structure, however, applied to the superior houses; the ordinary dwellings of the citizens being wood and thatch.

In the provincial towns a somewhat refined taste had begun to diffuse itself, especially as regards the carvings in the fronts of houses, while the interior and other parts still continued paltry and mean in appearance. In the important requisites of space and convenience, the ordinary dwellings of the citizens and burgesses had, however, undergone but little improvement. A narrow façade, with a gable end overhanging the street, were the general features of that class of buildings, from the thirteenth to the seventeenth century; and though in the nineteenth century all classes of the community are incomparably better lodged, in proportion to their means, than in the fifteenth, yet there is a greater similarity between the buildings of the two periods than may be obvious at first sight. The compact plan, the narrow front, the moderate elevation, and the contracted apartments, are still the peculiar characteristics of the English town-house, established in accordance with our domestic habits, pertinaciously adhered to through the lapse of ages, and even adopted in later times in edifices to which they are little applicable.

The origin of the palatial and domestic architecture, known as the *Tudor style*, has been traced from the gradual combination of the house and castle of earlier times. Henry VII.'s palace at Sheen, near Richmond, was one of the earliest buildings in which this style assumed a distinct character, and the first example of an English royal palace executed throughout its whole extent upon a complete and digested plan. Henry VIII. largely increased the new style of building by employing foreign artists; both Jerome of Trevis and Hans Holbein, whose genius was almost universal, designed, modelled, painted, and constructed for that monarch.

Under James I. the line is distinctly drawn between the ancient and modern styles of architecture in England. The classical style broke upon us with such peculiar brilliancy, that we outshone for a time that of any contemporary school of Europe. We adopted Holbein and Vandyke; we borrowed Rubens; but we produced Inigo Jones, the great architectural master-mind of his age. Under the direction of these minds classical architecture became re-animated in all its grace and purity; and the object of setting up the ancients for their model was not to *imitate*, but to *think* like them. They had before them the works of their Roman predecessors, who had successfully adapted the architecture of the Greeks to their own exigencies; and in a similar spirit, and with no less success, they recast the same elements into new combinations, suggested by the civil, religious, and

domestic usages of modern life. The Palace of Whitehall and the portico of old St. Paul's were the result of their labours.

Wren, with his remarkable genius, carried the new style to perfection; while Vanbrugh marked the point of its decline, which it rapidly attained under the direction of a Burlington and a Kent. Paine and Carr merely preserved the dull level to which architecture had fallen; the genius of Chambers, however, partially relieved it from its tame condition, while Adams reduced it to the baldest state of plainness that it is possible to conceive. Wyatt, Soane, Smirke, Nash, and Wilkins, had each their peculiar merits, and have left behind them, in one form or other, sufficient evidence that the genius of architecture is not extinct in this country, and that it only requires a healthy and judicious stimulus to render it as it once was, the most flourishing of all the schools in Europe.

Every building, of whatever magnitude, ought to express its peculiar *purpose*; and to this end the architect should study with attention even the minutest parts. The first object to be secured is the designed utility of the structure; the next, suitable arrangement and consistent ornament; and if these be effected the design will naturally develop its own form and beauty, with scarcely any effort to assist it. It is, moreover, the province of the architect only to render that beautiful which is manifestly useful.

From the preceding remarks it follows that the three great objects to be attained in building, whether in a cottage, a mansion, or a palace, are *fitness*, *purpose*, and *propriety*. Each of these has its peculiar beauty, the sum of all being the perfection of architectural science.

Man, in raising the first structure, had one primary object in view —to secure a shelter. This was establishing the first principle of architecture, and is called the principle of *Fitness*. To mark his progress in civilization, man next impressed a distinct character upon his habitation, expressive of his peculiar condition. Hence the second principle—the expression of *Purpose*. As the beautiful invariably springs from the useful, the finer feelings of man's nature next developed themselves with order, symmetry, and proportion, which created naturally the principle of *Propriety*.

Fitness, or use, is the first principle to be considered in all buildings. Those who care very little for any other character in a dwelling, generally pride themselves upon the amount of convenience they have been able to realize in it; and it is scarcely possible to conceive a worse taste than to decorate a dwelling which is wanting in

comfort; for the beautiful is never satisfactory when not allied to the true.

In a dwelling-house, our every-day comfort is so entirely dependent upon a convenient arrangement of the rooms, or plan of the interior, that this is universally acknowledged to be the most important consideration. To have the principal rooms situated on the most favourable side of the house with regard to aspect, in order that they may be light, warm, and airy, and, in respect to view, that they may command the finest prospect, are *desiderata* in every kind of dwelling. In all climates the stormy quarters are the worst aspects, and the fair-weather quarters the best.

In arranging the different apartments of a cottage, villa, or mansion, variations will naturally arise out of the peculiar circumstances, the mode of living, or the individual wants of the party by whom it is to be occupied. Thus, a family living in a secluded manner would prefer having their apartments constructed for convenience alone, as their object is domestic ease and comfort; on the other hand, a family devoted to social intercourse would prefer one or two handsome apartments, which could only be constructed at the expense of other considerations. What, however, may be fit and convenient for one, would be quite unsuitable for another; but there are certain rules of *fitness* in construction which admit of nearly universal application. For instance, a dining-room should obviously be within convenient reach of the kitchen; the drawing-room, parlour, or best apartment, should look out on the most beautiful view; and the library may occupy a more secluded position, as it requires less attention to outward objects, the *material* whence it dispenses enjoyment being within itself.

There is, likewise, a *fitness* in selecting the materials for a building. Stone is to be preferred to brick for general purposes, though brick has its advantages; but when we are restricted to the use of one material, both *fitness* and good taste demand that there should be a correspondence between the material used and the style adopted for building. Heavy and massive architecture, such as may be required in a mansion or temple, should be built of stone only, being the most solid and enduring substance; but in a cottage or villa, which are lighter, and more fanciful in their style, bricks may be more appropriately used, that material being more in harmony with the expression of the form and outline.

Expression of Purpose, or the second principle in construction, is frequently exhibited with sincerity, and in some instances even

naïvely. The expression of purpose is conveyed by the leading features of a building, or by its whole appearance, which suggest the end in view, or the purpose for which it is intended. A church, for instance, is easily known by its spire, or a barn by its plain large doors, and the absence of chimneys; reason, in these instances, suggests a feeling of satisfaction on finding them to be what they appear —that is, with the truthfulness of the expression. Whatever, therefore, tends to heighten expression of purpose, must grow out of some quality which connects itself in the mind with the use for which it is designed; and the most perfect mode of insuring admiration for any structure, is to render it expressive of the purpose for which it is built.

Not only should the general character of the structure denote the end in view, but every portion of it should be made, as far as possible, to convey the same impression. The various useful features entering into its composition should all be expressive of the end for which they are intended, and should appear to answer their purpose. Thus, large windows indicate spacious and well-ventilated apartments; and although propriety requires the windows of the principal rooms to be made larger than those of the chamber storey, yet the latter should not be shorn of their due proportions, so as to be expressive of imperfect accommodation. A common error, which is too frequently perpetrated, is the introduction of short attic windows into the second or third storey of a house; and however satisfactory such dwellings may be in other respects, the expression of low and confined rooms, conveyed by these cramped windows, destroys all pleasure in contemplating their exteriors.

The prominent features expressive of purpose, in a dwelling-house, are the chimneys, the windows, and the porch; and the architect who desires to raise the character of his structure above mediocrity, will bestow particular attention upon these several portions of it.

Fitness and expression of purpose, therefore, form the groundwork upon which architecture rests; but architecture which goes no further is only a useful, and is scarcely entitled to the appellation of a *fine art*. It is simply *building*. The true artist breathes a life and soul, which is *beauty*, into the dead materials of wood and stone, and they speak a language that is understood as readily as that of animated nature. The mechanic blocks out the stone from the quarry; but it is only the sculptor that moulds the cold marble into a passion or a sentiment that endures for ages; and strikes human speech, as it

were, dumb with its voiceless eloquence. A Greek temple, or an old cathedral, speaks to the soil of the spectator, if nicely attuned to the harmony of construction, as audibly as the most impressive of human voices. Even a Swiss châlet, with its drooping, shadowy eaves, or an old English cottage, with its quaintly-peaked gables, embodies a sentiment in its peculiar form, which takes hold of the mind, and convinces us that, in some way or other, it has a living power. To reproduce the beautiful in this manner, and to infuse a spirit and a grace in forms, otherwise only admirable for their usefulness, is the *ideal* of architecture as an art of taste, and its inspiration may be felt in a nook-hidden cottage as well as in the lofty dome of St. Paul's. As all the satisfaction, therefore, which the reason experiences in building as a useful art arises from fitness and expression of purpose, so all the delight which the imagination receives from architecture, as an art of taste, is derived from beauty of form, and from the *sentiment* associated with certain modes of building.

In the design of a structure, there are certain leading rules which should never be lost sight of, in its composition, however simple, which constitutes the sources of beauty, common to all styles. The first is the principle of *unity*, which is of the highest importance in all works of art. There should be unity of design in all portions of the same building, showing, by a correspondence of its various parts, that they all originated in the same mind; a unity of style, avoiding the introduction, in an established mode, of any portions or members not in keeping with that mode; and a unity of decoration, evinced in the appropriate application of enrichment to the whole, other than to a single part, of an edifice.

The next principles of composition are those of *uniformity* and of *symmetry*, which are not exactly synonymous terms. Uniformity in building is the repetition of the same forms in the different portions or sides of a building. A hut, however rude in form, may be called a work of art, because its several parts could never have been arranged by chance; but give a regular form to that hut, and you will have an idea not only of art, but of cultivated or improved art. There can be no doubt, therefore, that the love of regularity is strongly implanted in the human mind; since regularity is the first principle which displays itself in the works of man, composed with a view to beauty. Hence persons, who have little taste or imagination generally, prefer a plain square or cube to other forms for a house; this being its first principle of beauty which they are able to discover in architecture.

Uniformity may be termed the balance of two regular parts, while symmetry is defined as the balance of two irregular parts; in other words, uniformity in works of art is artistic *regularity*, and symmetry is artistic *irregularity*. There are irregular structures without symmetry; but in all irregular compositions which appear satisfactory, it will be found that there is a kind of hidden proportion which one-half of the whole bears to the other; and it is this balance which constitutes symmetry. Those who have but little cultivated taste for architecture, prefer in general a regular house to a symmetrically irregular one, because their reason simply demands to be satisfied; but with minds of a higher order of cultivation, and whose taste and imagination demand a more varied beauty, the irregular building will be chosen, as affording more intense and enduring pleasure.

It follows, necessarily, from the preceding observations, that whenever architecture becomes an active revelation of the mind—whenever the internal spirit of genius assumes an outward development by its aid—it is to all intents and purposes a fine art. It also follows, that there may be as true a principle of "fine art" in a modern town-house as in an ancient temple; in a simple country cottage as in a magnificent cathedral; just as much so indeed as the fine-art spirit, in the unsophisticated "Blind Fiddler" of Wilkie, is of kindred excellence to the transcendent spirituality which breathes in the "Transformation" of Raphael. In many instances, both in ancient and comparatively modern times, the conception and the execution of great works have been entrusted to the same hands; for, if historical tradition may be relied upon, the designs of the finest temples and statuary of ancient Greece were struck, so to speak, at the same intellectual mint, and their execution entrusted to the skill of those who conceived them. The same remark will apply to Italy, on the revival of art under the Medici, when Michael Angelo and Raphael shone with such peculiar lustre in their respective spheres. The first of these great minds was not confined to one single department of art, but was equally eminent in all; and the last could furnish designs of the highest order of architectural excellence, as well as impress the character of his fine genius upon canvas or fresco.

If the greatest minds of old, then, could busy themselves in the arrangement and construction of merely subordinate things, surely we moderns can imitate them in this respect. It is much easier, it may be said, to acquire a knowledge of rules than an insight into principles. True; but the spirit which animated those distinguished

minds is by no means extinct; and if it be applied with the same diligence as formerly, our architecture will assume the same features of excellence as theirs, whether it be in a cottage or a cathedral.

CHAPTER II.

GENERAL PRINCIPLES OF CONSTRUCTING HOUSES—SITE FOR A COUNTRY RESIDENCE.

HAVING decided upon the plan, the next consideration is the choice of a site. This point is of considerable importance. The most essential qualities of a good site are those that are most conducive to health. A cheerful situation is, above all things, to be desired, as it generally has a beneficial influence upon the spirits. The position of the house, in short, ought to be such that it would have the benefit of the sun every day in the year. The sum of human happiness is more dependent upon what may be termed minute trifles than many of us imagine; a little attention to them, therefore, in raising a structure for our own especial convenience and comfort, is absolutely necessary.

Wherever there is a choice of situation, the proximity of marshes, fens, boggy ground, or stagnant water, should be studiously guarded against; and if rivers are near, the site of the house should be on elevated ground, so as to be out of the reach of fogs and other unwholesome miasmata, which water periodically generates. Lord Bacon wisely remarks, "that he who builds a fair house upon an ill seat, committeth himself to prison; neither do I reckon an ill seat only where the air is unwholesome, but likewise where the air is unequal; as you shall see many fine seats set upon a knap of ground, environed with higher hills round about it, whereby the heat of the sun is pent in, and the wind gathereth as in troughs; so as you shall have, and that suddenly, as great diversity of heat and cold as if you dwelt in several places."

In localities where the inhabitants are healthy, cheerful, and remarkable for longevity, these may be regarded as possessing salubrious air, and little subject to the inconveniences so ably sketched by the great philosopher; but such localities are an exception, and more dependent upon accident than choice, for experience daily proves the truth of Lord Bacon's remark, and, though fully cog-

nizant of the results, we yet commit the same errors, and consequently perpetuate the same evils. Those who have a choice, in fact, seldom attend to the suggestions of the philosopher, obvious as they must be to even the least observant capacity. To pursue the subject, however, a little further: easy access to public roads and conveyances, with supplies of water and fuel, are indispensable requisites in the choice of a situation. Again, it is preferable to have a house sheltered by trees than by mountain scenery, because the former afford a cool and refreshing air in the heat of summer, and in winter they serve as a shelter from the keenness of the cold winds which periodically prevail; while mountains, especially if their position he directly east or south, are singularly disagreeable at certain seasons of the year, and only afford a partial protection from the winds. Wherever clouds, also, are frequently gathering, it must be an unhealthy site, for vapours are the natural complement to clouds; and as they hang about and saturate the air with their dampy particles, there may be expected agues, rheumatism, and other "ills which flesh is heir to" under such peculiar influences. A soft breeze, moreover, is preferable to a strong wind; but the stiffest wind is less hurtful to human health than a heavy and sluggish atmosphere which generates so many physical inconveniences. It follows, therefore, that the site which can command a good current of air, whether circulating gently or strongly, ought to be chosen before all others for building purposes; and the more we can secure the several advantages just enumerated, the more likely are we to augment the sum of comfort and convenience in our habitations, at which we are continually aiming, but very rarely attaining.

THE IMPORTANCE OF EMPLOYING AN ARCHITECT IN ALL BUILDING UNDERTAKINGS.

The most economical method, and in that word we include the beauty, the convenience, and the comfort of a building, is to employ an architect in all architectural undertakings.

The great disproportion which frequently occurs between the estimate, and final cost of a house, is a common source of disappointment and vexation. This principally arises from two causes:—first, there is generally the want of a well-digested and thoroughly satisfactory plan, before the contracts are made. Secondly, while the building is in progress, the subject opening on the mind of the owner, new arrangements or alterations in the plan are suggested; an additional room here, a closet or staircase there, would, it is discovered,

add greatly to the elegance or convenience of the house, and they are, of course, at once introduced. Thirdly.

Proper Specifications.—The specifications of a building, to be contracted for at a certain price, are supposed to embrace every portion of it, and every item of the expense. Now, to draw up a full and complete specification for a house, an accurate knowledge of everything relating to building—a knowledge that few builders are found to possess—is an indispensable requisite. Specifications are too frequently drawn up, especially in the country, at the suggestion of the proprietor, by the builder, and include all the particulars that occur to him at the time; but in carrying them out, it is found that so large a number of items have been overlooked, that the *bill of extras*, at the close of the work, amounts to a large per-centage on the whole estimate. In the specification given at the end of this little work, therefore, it will be understood that it is only given as a *form*, into which all local details are to be inserted by the parties making the contract.

To obviate these evils, it is necessary to have complete drawings of every part of the building, before it is commenced or contracted for, in order that no material alteration need be made while it is in progress. A competent and experienced architect can alone furnish these; and by adopting this plan, the work will be done at a lower cost, and much better in quality than otherwise. The reason is obvious. The builder will exercise his utmost judgment, both as regards labour and materials, on the contract plan; while the architect retains the power to inspect the work, and reject whatever may not be of a proper and specified quality.

The most mortifying feature, to a person of cultivated taste, in the country architecture, is the violation of correct proportions, of unity of decorations, and of appropriateness of style. These defects arise sometimes from the indulgence of the fancy or caprice of the proprietor, and sometimes from the defective advice or worse plans of the builder employed.

When we have really decided to build, the difference between a common form and an excellent one may at once be secured in favour of the latter by applying to an architect of talent and experience. The small addition which this will make to the whole cost of the building is a trifling consideration, when we reflect that in the *design* lies the whole *individuality* of the building, whether it shall be full of beauty, grace, or picturesqueness, or abound in uncouthness, incapacity, and foolish conceits—a matter of the more importance, as

it is to continue before our eyes, and become identified with ourselves for perhaps a lifetime.

The usual charge for drawings, specifications, and superintendence while in progress, is 5 per cent. on the whole cost. This includes working drawings for every part of the interior and exterior, and a constant supervision of the work in progress. Not only does this insure a thorough and satisfactory execution of the plans adopted, without any personal annoyance to the proprietor, but, in the case of all architects of standing, experience proves that a building of any considerable cost can be far more economically and substantially erected by an architect than by any proprietor not familiar by long practice with building.

The old adage says, every man may be his own lawyer, or his own architect or surveyor; but he usually has to pay much more dearly for the privilege, when he has any business of importance in hand, than he supposes; and we cannot counsel him to undertake the perplexity and vexation that generally result from it, if he can find a professional man of integrity and ability to perform the task so much more satisfactorily for him.

CHAPTER III.

FOUNDATIONS.

THERE are two points to be especially considered in the structure of a house—the foundation and the roof. If the first be solidly built, and raised upon a proper basis, it will support its superstructure; and if the latter be framed skilfully and worked in carefully there will be little chance of inconvenience in that quarter. Two of the greatest evils, however, to be guarded against in building are—dampness and decay, arising from a defective foundation, and a continuous outlay and costly inconvenience from an unsound roof. To obviate the first and secure a substantial foundation, which will bear without flinching the weight of its superstructure, one or two things must be especially attended to. In the first place, if there be a choice, select a gravelly soil or one imbedded with stone; these conditions may be said to form a natural foundation, which requires little or no artificial preparation. The next best is strong clay; but, if exposed to the

weather, it is apt to split or slake into sludge, according as the heat or rain prevails. A bed of gravel, which is pretty firmly placed, requires little or no artificial means, as we have just remarked, to render it a safe foundation; but in localities where clay, sand, loam, or earth prevail, recourse must be had to those means, in order to make the ground sufficiently compact and solid to bear the weight of the building. The great object, then, in dealing with soils of this kind, is to keep them as much as possible from the action of the atmosphere. This can only be effectually accomplished by covering them with a good concrete, which, if properly prepared of sand and gravel, and cemented with a due proportion of lime, becomes an artificial rock, and capable of bearing almost any weight that can be placed upon it. Every inequality of settlement and lateral yielding of the supporting material are prevented by adopting this precaution; and the fractures which so frequently disfigure different structures, and endanger their stability, are likewise completely obviated.

DRAINAGE.

Before we dilate, however, upon the nature of foundations, let us direct attention to the drains, the structure of which, though of the first importance, is not sufficiently attended to. In digging to form the foundation, especially in towns, a proper level ought to be taken in order that drains should have a regular fall into the common receptacle or sewer, which would effectually take off the refuse. In addition to this precaution a close trap should be fixed at the junction with the sewer, to prevent rats and unpleasant odours from coming into the drain, both of which are of common occurrence. These inconveniences most householders in towns have, more or less, to endure, and in many instances they prove a positive nuisance; for with rats in the house, and odoriferous smells constantly assailing the olfactory nerves, there can be but little comfort or enjoyment, however convenient may be the arrangement in other respects. A common S trap is sufficient for this purpose, and is easily and cheaply procured; though regular builders, as they are called, seldom pay attention to this point, and generally shirk it unless a rather sharp eye be kept upon their proceedings.

TRAP.

In writing upon the subject of buildings for the humbler classes, Mr. R. Scott Burn has some judicious remarks upon drainage, of

which we gladly avail ourselves. He says, in a recent work,* that "in the laying of the drains great care should be taken that they have a sufficient fall—the greater the better; and it is also to be noted that the place of discharge of the liquid should never, in any case, be an open cesspool. In districts where there are streets regularly drained, the place of final deposit of our household fluids must necessarily be in the street sewer (although in many instances defectively conveyed). In agricultural districts, where it would be utterly inexcusable to throw it away—valuable manure as it is admitted by all to be—the place of final deposit must be the liquid-manure tank, which should be placed at as great a distance from the house as possible. The drain-tubes used should in all cases be of stoneware; a tube of four inches diameter will be ample enough for all ordinary cottages. To prevent the escape of unhealthy and noxious gases from ascending to the interior of the house from the drains, it is absolutely essential that *all outlets should be carefully trapped*, and the drains ventilated. There are many forms of 'stench-traps' now before the public, all of which are generally efficient. In laying drains, of whatever construction, it is essentially necessary to make the joints water-tight. All escape of the liquid only serves to hasten the blocking up of the drains by the accumulation of the solid matter. Water is the only certain vehicle to insure the removal of the solid part, and it therefore should be confined to the drains."

ARTIFICIAL FOUNDATIONS.

If the soil under the building be even of a dry and hard nature, it is occasionally exposed to the influence of damps, which arise from natural causes, and are almost inevitable; therefore it is always best to have recourse to artificial means to counteract their effect; but if the soil happen to be of a soft nature, which frequently occurs, it is indispensable that a solid, compact, and if possible a dry quality should be imparted to it. To effect this a *layer of concrete* is found the most effective. The best concrete is composed of Thames stone-ballast, unscreened, and blue lias limestone, in due proportions. The ballast and lime are to be thoroughly mixed with each other in small quantities at a time, the lime being slaked with a little water at the moment of mixture. When properly applied this concrete not only proves extremely durable, from its binding properties, but also effectually excludes the damp, the most destructive of all agents to

* "Dwellings for the Working Classes." By Robert Scott Burn, M.E. Blackwood and Sons.

human habitations. Concrete, however, is seldom used on gravelly foundations, as that material generally lies in beds, and is presumed to be sufficiently firm to support any given amount of weight that may be placed npon it; but the means of flow and escape are sometimes imparted to beds of gravel as well as to other soils; therefore a layer of concrete would preclude any danger that might arise on that score. The trifling extra expense, however, whish would be incurred by using the concrete in such cases, operates like a prohibition upon it; and the builder, who uniformly conducts his work upon the narrowest, and, as he supposes, the most economical basis, is glad of an excuse to evade it. A coating of cement, under the joists, is all that is considered sufficient for foundations of this kind, and in some instances even that is dispensed with.

There is one principle, however, that must be uniformly observed in preparing foundations—namely, the artificial means of support must be in proportion to the hardness or softness of the ground upon which they are made. On a soft and yielding soil the footings should be extended as much as possible, in order that a greater bearing surface may be imparted to the mass; and even upon a dry or rolling soil, such as sand, care must be taken not to contract it too much, for fear of a sinking in one portion or another. There are several methods employed in this preparation. Some builders use layers of planks; others a network of timber; whilé in some instances inverted arches of wood distribute the weight of the superstructure over the whole area of the foundation. This is, however, one great and insuperable objection to all these modes of preparing a foundation—the difficulty of keeping the timber uniformly wet; as it is apt to decay when subject to the alternations of dryness and moisture. Concrete, therefore, compounded of the materials described, is the best and safest basis for a building, wherever it may be raised. "In the case of a foundation," remarks a highly practical authority, "partly natural and partly artificial, the utmost care and circumspection are required to avoid unsightly fractures in the superstructure; and it cannot be too strongly impressed on the mind of the reader, that it is not *unyielding*, but a *uniform yielding* foundation that is required; and that it is not the *amount* so much as the *inequality* of settlement that does the mischief."*

The common method of forming foundations for buildings is simply to dig down from twelve to eighteen inches deep, whatever may be

* "Rudiments of the Art of Building," &c. By Edward Dobson, A.I.C.E. Weale, 1849.

the nature of the soil. This is highly defective, and frequently proves destructive to the building itself, to say nothing of the inconvenience of the occupant, which assumes so many forms. In a gravelly soil the builder ought to dig down at least eighteen inches; and in a clayey or earthy soil, not less than from two feet to two feet six inches will be found effective. This depth of digging will require a little more concrete, it is true, and add a little more to the expense; but it will amply repay any extra of this kind in the superior character and quality which will be imparted to the structure.

There is also another point of considerable importance in building, and which is too frequently neglected. The joists are often laid upon the ground, or only a brick high, whereas they ought to be raised full eighteen inches above it; by this means the timber is kept from decaying, the brick-work remains sound, unhealthy odours are dissipated, and a clear current of air keeps the foundation dry and wholesome. To effect this, however, the first three or four rows of bricks should be of the best and hardiest quality, and cement used, and over these bricks it is now usual to lay a course of slate in cement. This prevents the rising of moisture in the walls; and they will now, with the aid of gratings to circulate the air, be kept dry and strong, and almost impervious to damp.

ROOFS.

Next to the foundation there is no more important part of a building than the roof. If properly constructed it acts as a ligature to the whole fabric; but if not properly tied and secured, it has the effect of thrusting out the walls, or otherwise damaging them.

No part of the practice of building has been more the object of caprice than the proportions of the roof. At the present time, even, we meet with almost every variety of proportion which can subsist between the height of the roof and its span. In ordinary dwellings the height varies from one-third to one-fourth part of the span; in other cases, the proportion depends upon the taste of the architect, and the style of the building.

Roofs that are high-pitched discharge rain and snow more quickly than those which are lower; they are also less liable to be stripped of their covering by the wind, and the rain is not so easily blown through their joints; but they are more expensive than low roofs, as they require larger timber, and a greater quantity of covering. But, though low roofs possess the advantage in point of economy, they require large slates and greater care in the execution.

The form of roofs to modern buildings, especially in towns or cities, where houses are built in lines to form streets, is what is termed the V roof, and which probably is the worst, from being so faulty in its construction. The whole weight on this form of roof is thrown upon the gutter plate, which receives the extended timbers, and which, running from back to front, has little more than the quartered partition for its support. The latter, also, is frequently of bad construction, the timbers not being properly trussed together; therefore, instead of acting as a support, it becomes highly dangerous to the ceilings and floors beneath, and frequently causes them to sink out of their proper position. The doors and windows, as a consequence, require to be re-hung, and are almost constantly out of repair in one form or other.

There is another evil in connection with roofs, which ought to be carefully guarded against. The making of rooms in the roof compels the carpenter to vary the length of the rafters, in order to gain height, which has the effect of throwing an unequal pressure upon the walls, the largest rafters receiving the greatest weight, which throws a greater thrust upon the abutment of the shorter ones. An imperfectly formed roof will always have a tendency to thrust out the walls, while the same quantity of materials, or even less, if properly put together, will not only support itself, but act as a tie to the whole structure. The ingenuity of the carpenter is, therefore, displayed in making the strongest roof with a given quantity of timber; and if it be framed before it is put up, the work generally proves sounder and better, and, when properly braced, the wood-work seldom gets out of repair.

If there be gutters to the roof, which is frequently the case, no dirt or filth ought to be permitted to remain; and the incline of the roof ought to be sufficient to carry off whatever may fall upon its surface; if this be not attended to, the water is apt to accumulate, and force itself under the slates, when it drips down into the rooms beneath. To obviate this disagreeable inconvenience, however, one or two things must be strictly attended to. The gutters, for example, ought to be of good width, and the lead should be turned up under the slate from eight to ten inches, whereas it is seldom more than two or three inches, the workmen frequently cutting off a slice for their own purposes. Fillets of wood should also be put under the bottom row, which prevent the "drip" from getting in the roof; and, as an improvement upon this plan, instead of putting the fillets merely to nail the slates to, which leaves open spaces, five-eighth

wood should be substituted, which keeps the slating more solid and better covered. The slates should, likewise, be slightly grooved, which prevents, in a great measure, the water from drawing up the inner surface by a sort of capillary attraction.

Zinc should be avoided in gutters and rain-water pipes, as it quickly decomposes; lead for the first, and iron for the last, being the best and most economical metals to be used.

There is, moreover, no better covering for roofs than slate; it is not only clean and durable, but it is also more economical and requires less repair, if properly put on in the first instance, and selected of a suitable quality and colour.

STAIRCASES AND TRAP-DOORS.

Sufficient attention has not been generally paid to the construction of staircases, even in first-class houses; a great improvement, however, has recently been suggested by the Board of Health,* which is deserving the utmost consideration, from its ready adoption.

The suggestion to which we allude comprises two distinct improvements, either of which, or both, can be adopted; and neither of which should be neglected if comparative safety from fire be desired. The first is, to carry up the well throughout with nine-inch walls, and to have the several doors opening on the well made of double thin sheet-iron, with one-and-a-half inch air-space between each sheet, and the whole representing a four or six panel ordinary door. These doors must be closed every night, so that in whatever apartment the fire may chance to arise, they would effectually confine it from the staircase, which in almost all cases becomes a stimulant to its ravages. Constructed in this manner, and with these simple, and really economical precautions, the staircase may be kept almost intact from the ravages of the fire, while the whole structure is in danger of being destroyed. Under these circumstances a means for the prevention of life and property is preserved, which the firemen would instantly turn to account.

The second improvement, however, is more simple, and is indispensable as an aid to the other. The common practice of placing the trap-door at the top of the staircase to communicate with the roof has been the cause of a vast destruction of human life; in these cases the staircase becomes a chimney-vent, increasing the power of the

* The public, we believe, are indebted to Mr. Gardner, a talented surveyor, for this improvement. On its communication to the Board, its adoption was almost immediately recommended to the public.

fire, and, from its attractive power, quickly filling itself with smoke and flame. To add, also, to the evil effects just enumerated, the bolts of the trap-door are difficult to be withdrawn, and its access is almost impossible under such circumstances. It is suggested, however, to place the trap-door in the attic, which can be easily cut off from the staircase by closing the door; and as the draught from below would not have so immediate and direct an action, the virulence of the fire and the ascent of the smoke would be considerably diminished, if not wholly obviated. The escape, too, would be much easier, for the inmates of the house are generally stifled with smoke before they can reach the place of exit; and if they do not become stifled, they are so bewildered in one way or other, that, under the present arrangement of buildings, they have little chance of saving their lives. With these advantages, though perhaps slightly magnified, the suggestion under consideration is well worthy of consideration, and if not thoroughly effective in itself, it may lead ultimately to perfection and safety in some other adoption.

CHIMNEYS.

A few remarks upon chimneys, and their structure, may not be out of place, especially as several improvements have lately been effected in this department of building. There is no greater nuisance to an Englishman of domestic habits than a smoky chimney; nor one that more thoroughly upsets the peace and comfort of our firesides. In a country, too, whose people, from necessity as it were, are an in-door people, the hearth and domestic chimney must be objects of especial importance; and any improvement in their structure, or any suggestion that will aid their effective utilities, immediately becomes an object of interest, and is submitted to the most searching scrutiny as to its practical qualities.

Chimneys ought not to be erected with any portion of timber, which occasions so many accidents as regards fire; they may, however, be built in party-walls back to back, provided the proper thickness of material between them be preserved. The breasts of chimneys and backs, together with the flues, must, in all cases, be *pargetted*, or covered with a coat of plaster, care being taken that timbers are not anywhere introduced for supporting the breasts, which must be carried by strong brick or stone arches, assisted by wrought-iron bars, as many as are requisite to each opening.

Care should also be taken that the gathering-wings and breasters are worked up strongly and truly; as workmen are apt to leave these

portions of a building in a hollow state, or filled up with any rubbish; whereas they ought to be solid and firmly constructed.

There is, likewise, another point of considerable importance in the structure of chimneys, and which is deserving of particular attention. The chimneys should be placed in the interior, not in the exterior walls; for when it is built in the latter it seldom continues warm during the twenty-four hours, as it parts with its heat rapidly to the cold external air. Now, as a good draught depends, in a great degree, on the warmth of a column of air, and this upon the heat of the chimney, it is evident that chimneys in the interior of a house must draw better than in the exterior walls. Besides this, a great deal of heat is retained in the body of the house by carrying the stacks of flues through it; and in point of external effect it is much more pleasing to see the chimney tops rising from the apex, or highest part of the roof, than from its lowest edge. These remarks, however, are more applicable to country cottages, or isolated buildings, than to town residences, although they are partially applicable even to them.

On the construction of fire-places and chimneys, thre are some judicious remarks in a work* recently published, and of whose excellent materials we have in one instance availed ourselves. Another extract, therefore, from the same quarter will not be found out of place here. Having pointed out the danger of constructing our chimney-places too large, in proportion to the grates which they are intended to receive, most of which are made upon an improved and correct principle, the author remarks:—"The recess made for the reception of the grate is so deep that, when it is fixed properly, a large empty space is left behind it. This is a source of danger; and on this point we quote some hints we have elsewhere given. The practice of making the recesses for the reception of grates deeper than absolutely necessary, should be at once condemned. The form of grates almost invariably used is that known as the 'register,' or similar construction. These, when placed in their receptacles, have a large empty space between the back and the wall; this often, in nine cases out of ten, having direct communication with the flue above, serves the purpose of a deposit for all falling soot, which accumulates until it reaches that part of the back of the grate which is apt to be—in fact, is—generally highly heated, and combustion ensues. This is evidently a state of things to be strictly avoided."

In whatever forms grates may be constructed, it is clear that a considerable amount of heat will be conducted from the fire by their

* "Dwellings for the Working Classes." Robert Scott Burn, M.E., &c., &c.

agency. The object, however, of constructing the sides and backs of grates being to throw the greatest quantity of heat into the room, a few remarks on the material in ordinary use may not be misplaced, especially as improvements are occasionally taking place in that department of industry. Iron, we believe, is the worst material for such a purpose; this metal is a good conductor, but, unless highly polished, a bad reflector, therefore by no means economical, as the object is to obtain a material that conducts slowly, and reflects quickly. Bricks will answer the first condition, and, if whitened, the second to a certain extent; but the best material by far for this purpose is the glazed pottery-ware, which has now become a somewhat extended branch of industry. The glazed linings of this material are the best reflectors of heat and the slowest conductors, two qualities which render them especially useful for heating rooms, and for making a fire go a long way, to use the language of domestics.

To return, however, to the construction of chimneys. Opinion is clearly in favour of adopting the circular or elliptical flue, in preference to that of a square or oblong form; or, if the latter be used, the corners are rounded off, which causes it to approximate in shape to the first. Wherever the interior parts of a flue are left rough they become nothing less than receptacles for soot, and proportionately diminish the upward current, which is the great desideratum in well-constructed chimneys; the interior, therefore, should be made smooth, as we have already remarked, by a good lining, or *pargetting*, of cohesive materials.

When flues are made circular, they are commonly built in the thickness of the wall as the building progresses, a circular mould being used, and drawn up as required; after the withdrawal of the mould, the inside should be carefully smoothed, which is, however, a somewhat slow and expensive process, and is now superseded by the earthenware tubes, which are made of all sizes, and occasionally curved; so that they can be used in any flue, however indirect its course may be. The internal smoothness of the earthenware tube is, also, another advantage, the soot not adhering to it for any length of time. As several opinions prevail as to the proper size of a flue, and consequently of tubes to fit in these flues, it may be as well to mention that for kitchen fires, in good middle-size houses, a tube from nine to twelve inches in diameter is sufficient, while for sitting-rooms from seven to nine is considered amply large. Care should be taken, in the construction of chimneys, to carry up all the flues to the

same height above the roof; otherwise, the tall ones are almost sure to overpower their shorter neighbours. Every flue, also, should be isolated, and have no communication with another, before issuing to the external air, which will prove a great preventive to a smoky chimney.

While we are writing, we find Mr. Bloomfield, a correspondent of the *Builder*, and evidently a practical man, propounding excellent views on this subject.

"The flue," he says, "should be smaller at the fire end, whether horizontal or perpendicular, and gradually expand to double the size, which will insure a good draught. I have made flues under ground, 14 by 12 inches, 250 feet in length, running into a shaft of 100 feet, 4 feet diameter on top, which drew so sharply that the flame did not touch the covering of the flue at all. For the sitting and bed-rooms of houses the mantel of the fire-place should be but 2 feet 6 inches from the floor; the flue should commence as much in the form of a common register as possible, say 9 inches by 9 inches, gradually expanding in the next storey to 10 inches by 10 inches; the next 12 inches by 12 inches; and so on to 14 inches by 14 inches, allowing of no check, and every incline of not less than 60 degrees. Build the chimney-stack 4 feet above the party-wall: each flue when finished being 14 inches by 14 inches, will not require chimney-pots to give it a good draught, unless a high tree or higher house is next your chimneys. The way of expanding the flues requires the upper breasts to be built larger than usual. The great cause of cramping the flues is this, that the builders will not set out the breast large enough in the basement storey, so that they corbel over and over, and that in order quickly to get their opening; consequently cramp the flue at every storey: my way only admits of corbelling over one inch in front, in every storey."

CHAPTER IV.

CEMENTS.

As cement has entered so largely of late years into all building purposes, and as its application has not always been directed by the same amount of practical sagacity, its peculiar excellence as a structural material is frequently questioned. Under these circumstances cement has its ardent advocates and its injudicious opponents; and to

strike the mean between these two extremes, we shall devote a few paragraphs to an analysis of the component parts of the material, and endeavour to point out when and where it can be used judiciously, or otherwise.

"In proportion as solidity and excellence" (writes an excellent authority*) "of materials have disappeared from English architecture, the use of various kinds of cements has become general. Of most of these, the question may be asked, Of what use are they in architecture? And very few will be the instances in which reply may be made as to their necessity." Another authority,† equally esteemed for his practical knowledge, remarks:—"The great and increasing demand for cement, and its great superiority for most purposes over lime-mortar, have induced manufacturers to turn their attention to the manufacture of artificial cement; and this has been attended, in many instances, with perfect success,—the artificial cements now offered for sale, formed by imitating the composition of the natural cement-stones, being mostly equal in quality, if not superior, to the Roman cement, the use of which has been partly superseded by them."

The basis of the various cements, and the chemical principles involved in their preparation, are nearly as follows:—When common limestone of any kind, unmixed with other mineral substances, is exposed to considerable heat, it changes its appearance and character, swelling out, and passing into a white powdery material, which quickly absorbs water with the evolution of much heat. This is known under the name of *quick-lime*. It was formerly supposed that the hardness of mortar depended upon the hardness of the limestone from which the lime used in its composition was derived. Smeaton, however, and since his time, Colonel Pasley, have clearly proved that the hardness of the limestone has nothing to do with the matter, and that the quality of the latter is mainly dependent upon its chemical composition. Limestones may be divided into three classes—pure limes, water limes, and water cements. The first is simply chalk; the second is more or less hydraulic, as the stone-lime or the lias-lime; the third, like the stones of Sheppy and Harwich.

If a paste is made of quick-lime and water, and exposed to the air, the result is a loose and friable hydrate of lime; but if a thin bed of such paste is interposed between two porous stones or bricks, the water is absorbed into these substances, and the thin bed of hydrate of

* "Specifications for Practical Architecture." By Alfred Bartholomew, Architect. Weale.

† "Rudiments of the Art of Building." By E. Dobson, M.I.B.A. Weale.

lime that remains takes the consistence of stone, and adheres firmly to the two surfaces with which it is in contact. This is assisted by mixing the paste with sand and gravel to the extent of two or three times its own weight, since the adhesion is greater to the foreign substances than to the particles of hydrate of lime itself. Such is common mortar; and as it only hardens after exposure for some time in dry air, it is not surprising that in damp places it sets with great difficulty, and in water has no tendency to consolidate at all. When it is required to fasten stones and bricks together in moist places, or under water, another substance is needed, and this is called hydraulic lime, or *hydraulic cement*.

There are, however, several kinds of water or hydraulic limes, all of which possess the common property, more or less, of setting under water. They are generally composed of carbonate of lime, silica, alumina, and oxide of iron. The simplest is obtained when about 10 or 15 per cent. of clay is combined with the original limestone, and when the calcination is not carried too far. In this case the lime solidifies under water, the hydrate of lime combining with the silicates of alumina and lime, which produce a substance insoluble in water.

Many calcareous clays or argillaceous limestones exist in nature having properties that lead to this result. When the proportion of clay is about 10 or 12 per cent., the mortar made from them takes about twenty days to harden in moist places; when the proportion of clay reaches 20 to 25 per cent., the hardening is complete in two or three days; and when it exceeds this, or is as much as from 25 to 35 per cent., the ratio of drying varies according to circumstances, but may be very rapid. The cement called Parker's, or Roman cement, is obtained by this admixture; but as there is great difference in the quality of the material, the result is equally affected. The materials for making the cement just mentioned are principally drawn from the clays of Sheppy and Harwich, which contain nodules of calcareous matter; and from the Oxford and Kimmeridge clays, and other similar deposits. In some instances these materials have been washed out to sea, and are there dredged up. The *Medina* cement is of this kind, but of lighter colour, and is made from the Hampshire septaria. The *Mulgrave* cement is made principally from the lias, and is considered a good hydraulic mortar. The *Portland* cement, which is much prized as a hydraulic cement, is made from carbonate of lime, mixed in definite proportions with the argillaceous deposit of such rivers as run over clay and chalk, pounded together under water, and afterwards

dried and burnt. The strength of this compound is very singular, being nearly four times as great as that of any natural kind. This cement makes a powerful concrete, as was proved by the several experiments made to test its binding properties at the Great Exhibition, when the Portland was found to bear to the Roman cement a ratio of $2\frac{1}{8}$ to 1. The proportion of concrete required is about a tenth or twelfth.

These several cements are composed essentially of carbonate of lime, from which the carbonic acid and water are driven off by burning in a kiln. Another group, however, exists, which may be called *plasters*, of which the base is sulphate of lime or gypsum, usually found in combination with nearly 24 per cent. of water, and frequently containing carbonate of lime and clay in small proportions. On being burnt at a low temperature, this mineral simply parts with its water, which it absorbs again readily, and with great rapidity, in subsequent exposure; but if a greater heat is applied it melts, and when cooled assumes a new and permanent form, not altered by wetting. Chalk is a pure carbonate of lime, consisting of about 5 parts of lime, combined with 4 of carbonic-acid gas. It quickly expands in slacking, and will bear from 3 to $3\frac{1}{2}$ parts of sand to one of lime, when made into mortar. This kind of mortar, however, is but of little value, as it hardens so very slowly, and in moist situations seldom *sets* at all, but remains in its pulpy condition, which renders it unfit for any work subject to the action of water, or even for external walls.

Gypsum, which has the property of parting readily with its water of solidification, and of re-absorbing it as quickly, is the basis of several materials which are used for cementing purposes. When mixed with water mechanically, after calcination, a part of the water enters into combination with the powder, and forms a true hydrate sulphate of lime, which collects into minute crystals, fitting into each other, and the mass becomes rapidly solid, though not very hard. If the solidification takes place in a mould, the most minute cavities are found to have been filled; and the result is a perfect cast, owing to the expansion which takes place while solidification goes on. Thus the calcined gypsum, mixed with water, becomes an admirable material for casting, and is commonly used for that purpose. *Plaster of Paris* is composed of gypsum, and contains 26 portions of lime, 37 of sulphuric acid, and 17 of water. It is largely used for internal purposes, for which it is admirably adapted, but not for external work, being partly soluble in water, like other pure limes.

Stucco is a combination of the same substance, with a solution of

gelatine or strong glue. This mixture dries more slowly than that made with water, and is more durable.

Puzzolana is composed principally of volcanic ashes, which are obtained from Italy and certain parts of Germany. This cement is of great service in hydraulic works, as it hardens quickly, even when applied under water with a small portion of the lime made from poor limestones. Mortar made with puzzolana has extraordinary hardness and durability, this material having a great affinity for lime and hydrate of lime, and forming a perfectly insoluble compound.

The several other cements, known as *Keene's*, *Martin's*, and the *Parian*, have one common basis—sulphate of lime. In these the plaster, in a state of fine powder, is put into a vessel containing a saturated solution of alum and sulphate of potash. After soaking for several hours, it is removed and air-dried, and subsequently rebaked at a reddish-brown heat. When taken out of the oven, it is again reduced to a fine powder, and carefully sifted; after this it is fit for use, but when slaked, a solution of alum is employed instead of pure water. When borax is used, the plaster is called *Parian*, but in the other case it forms Keene's cement. The kind called Martin's cement is made with pearlash as well as alum, and is baked at a much higher heat than the rest.

Scagliola is a costly and highly ornamental material, consisting of an imitation of marble, precious stones, &c. It consists of a coating of plaster mixed with alum and colour into a paste, and afterwards beaten on a prepared surface with fragments of marble. As an economical substitute for marble, it is in considerable request, and in many respects is like that beautiful stone, being hard, extremely durable, cold to the touch, and capable of receiving a perfect polish. The cement is prepared from the finest gypsum, broken up before calcining, and afterwards reduced to a fine powder and passed through a sieve. It is then mixed with aluminous matter and isinglass, and also with colouring matter; after this it is made up with alum, and as it is generally used only where the most beautiful and veined marbles are to be imitated, as many different colours and shades of colour must be mixed up separately, as there are in the kind of marble to be represented. Thus prepared, it is ready to be laid on to the surface intended to receive it, which has a rough coating of lime and hair already prepared. The different colours being laid on and mixed by the hand, the excellence of the work depends on the skill of the operator in imitating the style, the beauty, and the veining of the original. When the cement is laid on and has hardened, the surface

is prepared for polishing by rubbing it with pumice-stone, and cleansing it with a wet sponge. It is then polished by rubbing, first with tripoli and oil, and lastly with oil alone, which produces a lustre equal to that of marble.

The raw material of these several cements and plasters, the principal ingredients of which are carbonate and sulphate of lime, is mostly procured from the northern counties of this country. Derbyshire, Nottinghamshire, and Cumberland afford the largest and best supply. The neighbourhood of Paris is well known for the excellence of its gypsum; and in Tuscany also, gypsum, in a crystalline state, called alabaster, abounds in several places. The English gypsum is in beds of variable thickness, sometimes in lenticular masses, and occasionally in veins. It occurs extensively in the new red sandstone, and also in the clay deposits of the oolitic period. The harder kinds make the soundest plaster, containing generally a little lime, but the purer kinds are much whiter when burnt. In France the gypsum is burnt in open kilns, and is thus discoloured; but in England this is avoided, as the fuel does not come in contact with the plaster.

The objection to the use of cement simply assumes this form. It is applied frequently in wrong places and to wrong purposes; but if judiciously applied, it proves a most excellent material for structural purposes, and is capable of being manipulated to the nicest designs, and to the most durable forms. It is true that cement looks showy, and a great deal of bad work may be concealed when it is applied externally; but this objection may be raised against almost every other material which is applied to our ordinary wants, whatever may be its nature, or however applied. Cement forms no exception to this very general rule. The fault lies with those who misapply that material in building purposes, and with the system that designedly practises its misapplication. All cements, if applied externally, are liable to decomposition, from the metallic oxides, which they more or less possess, being affected by the atmosphere. The process of oxydation, under these circumstances, is uniformly generated.

In the finish of houses plastering has become, in some cases, more beneficial than wood, and is superseding the use of that material. It is, in fact, more economical. The best cement for this purpose is, perhaps, White's. It will bear more sand than many others in common use, and sets a great deal harder. The plasterer can run out two mouldings with neat cement of this quality, and will gladly shirk the sand; but if he brings it out with sand, though it costs

more time, it will materially improve the nature of the work. Skirtings, for instance, can be worked in a good cement, and have this advantage over wood—they are more durable, do not shrink from the floors, are not so susceptible to damp, and are more easily repaired when damaged. Skirtings, moreover, when made of this material, are not so liable to harbour vermin, from the resistance they offer to their attacks, and from their being no hollow spaces in their construction. Wherever circular forms are required in the material, cement can also be judiciously applied; and when a number of mouldings with large members are required, it is equally excellent. For niches and ornamental arches, cement has no equal, either on the score of economy, or for the ease and facility of its application. There is, likewise, another advantage belonging to a good cement; it can be painted over immediately, and may be made to represent the most beautiful graining of either wood or marble. But this especial care must be taken, that the cement be laid on laths, and not flush with the walls, otherwise the paint will flake or effloresce; the air which circulates between the laths and the walls, not only keeps away the damp, but prevents the metallic oxides in the cement from injuring the surface of paint. Under these circumstances the best preventive to the surface efflorescing is, perhaps, to mix a certain portion of sal ammoniac and hard water with the cement; but even this will not preclude the metallic oxides from their active agency wherever there is damp. With these conditions, a carefully prepared cement, such as White's, or Keene's, is preferable to wood, as it is not so liable to shrink or swell from changes in the weather. Nor ought we to omit the utility of cement for various decorative purposes. Here then is the principal value of cements, which are mostly obtained by the admixture of borax, alum, or some other salts of the alkaline earths, with the burnt gypsum in various degrees of purity. The chemistry of building, which ought to be a little more studied than it is, will scarcely suggest another application of cement for internal purposes.

Cement is generally, and in most instances, justly, applied externally under the following circumstances. Where dressings are required to outsides, such as string courses, lapels, and architraves, round windows, quoins, &c., and economy is a consideration, the cheapest material is cement. In this case a good Portland cement, mixed with a clean river sand, is fully equal to the best Bath stone, and has this advantage—it can be more easily repaired than stone. Again, where large cornices, or any heavy projections, are required,

about 2½ feet of the wall beneath ought to be bedded in cement, as it will form a good case; the wall will then acquire sufficient firmness and solidity to carry the incumbent weight, and balance the projection, even though it should be over the perpendicular line. This is a point of the utmost importance, as many lives are lost by neglecting it; yet it is not so frequently attended to as it ought to be. Cement may also be safely applied to fillet the slatings of roots against the brickwork, but care must be taken to fix cast-iron nails, about three inches apart, into the brickwork, to make the cement secure. Drains constructed of brickwork are frequently stuccoed with cement, but that material has been in a great measure superseded by glazed earthen pipes. In the placing of chimney-pots, in tile-cresting, and in flanching, there is, however, no material that has a fimer hold than cement; and in covering the joints of iron-work, to prevent corrosion it is found equally useful, though pipes cemented in this manner are liable to burst from oxydation.

It follows from these remarks that cement, if carefully prepared, admits of a varied application in building purposes; but as chemical science cannot wholly neutralize its tendency to decomposition, it requires a little discrimination to use it to the best effect.

CHAPTER V.

PLASTER—MORTAR.

Our remarks in the preceding chapter had reference principally to cements, which are in requisition for useful as well as ornamental purposes; but, as there is considerable distinction between the composition of cement and plaster, ordinarily understood, it may be as well to point it out. Cements, generally speaking, have for their basis carbonate of lime; and as the stone which contains this property easily parts with its carbonic acid and water, when subjected to a certain amount of heat, it quickly becomes what is called lime. In this state a portion of silicate of alumina, or other analogous substance, is added, whence results a material which rapidly absorbs the water necessary for its solidification, and becomes hard without being affected by external circumstances. Plaster, or the artificial cements, on the other hand, has the sulphate of lime, or gypsum, for its basis, which on being burnt simply parts with its solidifying agent, water, without undergoing decomposition. The re-admixture, however, of

water produces solidification, though in a somewhat altered form; and by adding some of the salts of alumina, borax, and potash at a certain stage of the process, the newly-formed material increases in hardness, and its absorbing power is materially diminished. In these admixtures lies the peculiarity of the various patented plasters.

The durability and security of every structure being mainly dependent upon the manner in which cements and mortars are prepared and used, we shall now devote a few remarks to the latter, particularly as to what ought to constitute its component parts.

Mortar, to be durable, should be composed of the best well-burnt limestone, sharp, clean river sand, and hair of cattle mixed in certain definite proportions. Authorities differ as to the proportions of lime and sand, but common experience has settled it as one of the former to two of the latter. The best sand for this purpose in and around the metropolis, is dredged from the Thames, above Westminster-bridge, and is deprived of its brackish quality. This is pure drift-sand, consisting chiefly of hard quartose, flat-faced grains, with short angles; it is comparatively free of clay salts, and of calcareous and gypseous qualities; it is also found to contain the smallest quantity of pyrites or heavy metallic matter, and suffers but slight diminution of its bulk in washing. The limestone that heats the most in slaking is the best, and slakes the quickest when properly watered. The Dorking stone generally answers these conditions. These materials should be thoroughly mixed in a pug-mill, or well tempered with wooden beaters, with a small portion of water, in the proportion of one of lime to two of sand, well chafed. The lime ought to be kept under a shed, and used as fresh and stiff as possible. No more than about a bushel of lime should be slaked at one time, and no more water should be employed than is required to reduce it to powder, when it ought to be immediately covered with sand to prevent the gas escaping, which constitutes its hardening quality. The mortar should be beaten three or four times over, so as to thoroughly incorporate the lime and sand, and to break any pieces of lime that may have passed through the sieve, the operation being performed with but little water. The mortar by this process is improved in strength: and if laid by for a time, it ought to be beaten up afresh before it is used, to save the time of the bricklayer. Care also should be taken to use it soft in warm weather, and rather stiff in cold weather.

There is a common notion among workmen, who generally reason upon too narrow a basis, that the best way to make mortar is to put one-half of lime with the same quantity of sand; this may be the

best way when the sand partakes of a clayey quality, which is exceptional; but when it is composed of the clean, sharp, and angular qualities of the best Thames-drift, then one-third of lime is sufficient to two of sand. Any alteration of this proportion is found to depreciate the quality of the mortar. Chemical analysis points out clearly the difference between the two. When the sand requires so large a portion of lime as one-half it is impossible to make good mortar, and for this simple reason—the hardness of the mortar depends on the crystallisation of the lime round whatever materials it may be mixed with, and which causes the whole to become a compact mass. If, therefore, a portion of the materials be clay, or any other friable substance, it follows that, as these friable substances are not changed in the slightest degree by the process of being mixed with lime and water, the mortar must be more or less friable, according as the quality of the latter prevails in the composition of the materials. If mortar, on the contrary, be composed of lime and sand in the proportions indicated above, and according to the qualities described, it will become hard, solid, and unfriable—for the sand is a strong substance, and not in the least friable, and the lime, by crystallisation, becomes also of a strong nature, so that a compact material cannot fail to be the result. This analysis clearly points out the ill effects of using in the place of sand, which is a strong body, the scrapings of roads, old mortar, and other rubbish, which consist for the most part of soft, muddy, and exceedingly comminuted particles. There is another point which is equally deserving of notice in the mixture of mortar. When lime has been kept long in heaps, or untight casks, it is reduced to a state of chalk, and becomes gradually unfit for mortar. The reason is simply this: lime reduced to a chalky state is incapable of crystallising; and as the quality of the mortar mainly depends upon the perfect crystallisation of the lime, the desired result under these circumstances cannot be produced. The quality of the water ought, likewise, to be attended to, especially when a choice is at hand. Rain water is the best, river water next; but if neither of these can be obtained, land water must be preferred to spring water.

An examination of the Roman ruins in this country and elsewhere has frequently led to the remark that the ancients must have used materials in preparing their mortar of which we moderns are ignorant, seeing that it adheres so tenaciously to other substances. It is now, we believe, pretty generally granted, that the durability of the ruins in question depended more on the method of preparing this mortar than on the nature or novelty of the materials used. When a small

drop of water, for example, is exposed to the air, the calcareous matter contained in it begins to separate from the water, and after passing through the process of crystallisation becomes, in fact, limestone. The perfection of the mortar or cement must therefore depend entirely upon the perfection of the crystals; and if the matter interposed, such as brick-dust and chalk, between the crystals of the lime be friable and brittle, the material will necessarily be of a weak and imperfect nature. But, on the contrary, when the particles are hard, angular, and very difficult to be broken, such as the best Thames-drift sand, the mortar invariably assumes a compact and solid form. That the crystallisation may be the more perfect, a large quantity of water should be used, the ingredients thoroughly mixed together, and the drying be as slow as possible. This process would have the effect of dissolving a large quantity of the lime and of rendering the mortar equally hard with that used in the construction of the ancient walls, and of an equally durable nature. The common practice, however, of plasterers at the present time, instead of making their mortar in small portions, is to mix a large quantity of materials at once, by covering the quick lime with a thick coat of three or four feet of sand, and then pouring on sufficient water to slake it. When the sand opens, and allows the gas to escape, the gap ought to be instantly closed, so that the lime may become thoroughly slaked, which is the principal object in a good mixture. This obviates, in a great measure, the blisters so frequently observed on the face of plastering when the material is badly prepared, which arises principally from bits of unslaked lime cracking and bursting out.

There are different methods of plastering, according to the quality of the work required, and the nature of the building to which it is applied. The commonest kind of plastering requires but a single coat, while the best receives as many as four, each different in the quality of the material applied. In this stage of building there is, therefore, considerable scope for shirking, or, as it is technically called, *scamping* the work; and that that is frequently done, the cracked ceilings of ordinary, and even of superior, houses amply testify. As a preliminary to plastering, however, great care should be taken to select sound and enduring laths, and not allow *single laths* to be placed when a *lath and a half*, or a *double lath*, would be much better. Single laths are the cheapest and thinnest; a lath and half denote one-third thicker, and double laths twice the thickness of single ones. The laths in common use are made of fir, which is imported from the Baltic and from Canada; the European wood, from its superior sound-

ness, being much preferred, though a little higher in price. Oaken laths are used for the first-class work; but the inferior fir are frequently substituted for them, to the great detriment of the structure. Fir laths are commonly fastened with cast-iron nails; but those of oak require wrought-iron, being harder and more resisting in their nature. On ceilings it is always advisable to use both three and four-feet laths, whatever be the nature of the wood, as the varying lengths increase the number of joints, and thereby augment the adhesive power of the surface. The plastering with this precaution will be materially strengthened, and receive what is technically called a stronger key or tie. The strongest laths should always be placed upon ceilings, and the slighter ones, if necessary to be used, upon the partitions, as the strain upon laths is greater in a horizontal than in an upright position.

The duty of the plasterer is to cover brickwork, naked timbers of walls, ceilings, and partitions with plaster, prepared according to the quality of the work required, and to make them ready for painting, papering or distempering. The cornices, and other portions of the building which partake of a decorative nature, also fall to his share of labour.

The materials commonly used consist of what is called *coarse stuff*; that is lime and hair, which is similar to common mortar, except that the hair is derived from the tanner's yard, and thoroughly mixed with the lime. *Fine stuff* is composed of pure lime, slaked with a small quantity of water, and brought to a proper consistence by the subsequent addition of a larger quantity. When it has had sufficient time to settle, the superfluous water is poured off, and it remains in a tub in a coagulated state; after which the water is left to evaporate until the stuff is in a proper condition for use. A small portion of white hair is generally mixed with the fine stuff, when it is required for the setting of ceilings. *Stucco* is composed of fine stuff, clean sand, and lime; and as it is the finishing coat of plaster preparatory to painting, colouring, and jointing, great care ought to be taken in its mixture. *Trowelled* stucco is the best kind of plastering, and is applied in superior apartments, intended to be painted. *Bastard* is used for similar purposes; but *rough* stucco is the mode of finishing passages, staircases, &c., in imitation of stone, and is frequently applied. This kind of stucco is composed of a larger portion of sand, and of a coarser quality, than that used in *trowelling*; the surface is also left in a rough state from the hand float, which is purposely covered with a piece of felt, that, on raising the grit of the sand, gives it the semblance of stone.

The simplest kind of plastering, however, consists in merely spreading a coat of lime and hair over brickwork, which is called *rendering*. *Pricking up* is the first coat of coarse stuff laid upon laths; when finished the surface is scratched over with the end of a lath, which forms the *key* or tie for the next coat. *Laid work* consists simply of a coat of coarse stuff applied to a wall or ceiling; and *two-coat work*, which is commonly used in cheap and run-up houses, consists of a coat of plaster, which is simply roughed over with a broom, and then *set* with finer stuff. *Floating* is a term applied to the second coat of plastering, which is brought to a plane surface with the *float*, a tool of which there are three kinds—the *derby*, which requires two men to use it from its great length; the *hand float*, which is used for finishing stucco, and the *quirk float*, which is required for angular projections.

The operation of floating, which requires considerable skill, is performed by raising strips of plastering round the surface to be floated, called *screeds*, which are raised to a level with the plumb-rule. When a ceiling is prepared for floating, nails are driven in it at certain angles, and along the sides, at ten feet apart, which are carefully made even by means of the level. Other nails are then placed exactly opposite to the first, at a distance of seven or eight inches from them; after this, the space between each pair of nails is filled up with coarse stuff, and levelled with a hand float, forming what are called *dots*. When the dots are sufficiently dry, the spaces between them are filled up with coarse stuff, and made level with a floating rule; this operation is called a *screed*, and is repeated until the whole surface of the ceiling is completed. For floating walls the screeding is precisely the same, except that the levelling is effected by the plumb-rule in lieu of the level. When the work becomes smooth on the surface by use of the floating rule, it is gone over with the hand float, and a small quantity of soft stuff, to make good any deficiency, is carefully applied.

The *setting* operation follows. When the floating is nearly dry, the setting, or finishing coat of fine stuff is laid on with the smoothing trowel, which is alternately wetted with a brush and worked over with the smoothing tool, until the surface becomes fine and smooth. *Stucco* is applied with the largest trowel, and worked over with a hand float; the work is alternately sprinkled with water, and floated until it becomes hard and compact, after which it is finished by being rubbed over with a dry stock brush. The water, in these operations, has the effect of hardening the stucco, which assumes a hard, smooth,

and glassy surface, after it has received a certain amount of sprinkling and trowelling.

There is, perhaps, no branch of building in which a larger degree of imposition is practised than in plastering, both in the preparation of the materials and in their application. Here master and man have almost an equal margin for what they call *scamping;* and that an advantage is mutually taken of the margin, the internal and external dilapidations of even newly-built houses fully prove. There are whole streets of recently constructed houses in the metropolis, and numerous detached ones around it, in which the plastering is of the most disgraceful and unworkmanlike condition, though in many instances provision has been made for work of a very different nature. Instead of allowing the *pricking-up* to become thoroughly dry, without which there can be no good plastering, however excellent the materials of which it is composed, the common practice is to commence *floating* as quickly as possible, the result of which is that the plaster has little adhesive quality, and in many instances cracks and falls ere it can be said to be thoroughly set. The master-builder, in these cases, saves in material and time—both of which he has a great interest in curtailing; the plasterer saves in time, trouble, and labour, which are equally precious in his eyes, and which he economises, in his way, as much as possible. Occasionally the master and man are in combination to *scamp* the work; but more frequently it is practised by one against the other; and reason suggests which of two parties, standing in the ordinary relation of master and workman, has the best chance to carry on the practice to the greatest extent. The masters, in many instances, have taught their men the art of *scamping;* and it would be irrational to suppose that the men have not bettered the instruction.

CHAPTER VI.

BRICKS AND BRICKWORK.

THERE is, perhaps, no article of common use which has been subjected to more experiments in the manufacture than bricks, and in which, until recently, so little improvement has been effected. Yet the materials of which they are composed are but few in number, and extremely simple in their nature; they are, moreover, easily procured,

for the principal ingredient used is more or less abundant throughout the entire surface of the country. Indeed, in some instances clay is the only building material that can be procured at a reasonable rate; for the cost of conveyance operates like a prohibition upon any other, however preferable it might be for use. The metropolis, for example, is virtually restricted to bricks for building purposes; for there are no quarries whence can be derived any kind of stone at a moderate rate. Were London, like Paris, in the immediate vicinity of a huge mountain, composed entirely of a fine freestone, there can be little doubt that that material would be preferred to bricks; but the geological position of the metropolis has determined the choice of its building materials; for the bed of clay, which substrates the foundation upon which it stands, extends in almost every direction, and also at a great distance from its centre. London has, therefore, no choice in the matter; otherwise we should not see so many streets of brick, and so many squares of stucco and painted cement.

The facts with regard to bricks have reference to the kind of clay used in their manufacture, the mode of preparing that clay, the admixture of it with other materials, the method of burning them, and the size, shape, and proportions in which they are severally prepared. All these are points of more or less importance, and to which practical skill has, within these few years, largely applied itself. The repeal of the duty, however, upon bricks has proved of great advantage in more respects than one: in the first place it has removed an obstruction which uniformly operated against any improvement in their make and shape, and, in addition to other advantages, it has brought about a complete change in the preparation of the materials of which they are composed. Unrestricted freedom of industry is, therefore, the most powerful incentive to improvement, in whatever direction it obtains.

Bricks are composed of an artificial preparation of clay, sand, and ashes, and are burnt in a clamp or kiln, the latter being preferable, from imparting a more uniform quality to the brick. Good brick earth, as it is called, is occasionally found in a natural state, but the mixture mentioned produces by far the best quality. The more pure the materials, however, of which it is formed, the harder and firmer the brick will be. The bricks made in the vicinity of the metropolis are mostly composed of a fatty earth called *brick loam*, of a yellowish brown colour, which takes, when burnt, a kind of gray colour. This kind of brick is as hard as the *reds*, made of the stiffest clay, and yields to the axe and rubbing stone just as freely, which is rarely the

case with brickwork. There are several methods of preparing the materials for making bricks; but the most approved one, at the present time, is as follows:—

The earth is usually dug in the autumn, and left in a heap exposed to the sun, air, and frost, until the following spring; the effect of this exposure to the elements is to reduce the mass and to disintegrate its component parts, which materially facilitates the subsequent operation of mixing and tempering. Alternate layers of sand and ashes are then placed with the earth in certain proportions, which are dependent upon the nature of the soil. From one-quarter to one-sixth of ashes is ordinarily mixed with the clay when common *gray stocks* are required, which prevents the bricks from shrinking and cracking during the process of burning. Sand is occasionally added with very soft clay; but it is not required with good earthy loam; and whenever it is substituted for ashes, the bricks are generally found heavy and brittle, and do not work so freely and pleasantly as they otherwise would do. Ashes have, also, another advantage over sand in the making of bricks: when mixed in proportions suitable to the quality of the other materials they diminish the consumption of fuel.

The longer the heap of materials is left to the exposure of the atmosphere, the better the bricks will turn out; indeed, two or even three years would not be too long, but economical considerations fix a limit much within that space of time. When the heap is broken up it is well beaten together, but with as little water as possible, in order that the materials should not harden and become dry too quickly; the mass is then reduced to a tough, viscous consistency, every kind of stone being carefully removed, which renders it fit for the mould.

Sometimes the tempering and mixing are effected by means of a *pug-mill*, in the form of a large tub, in which the materials are placed and well stirred about; they are then passed out at the side, and are ready for the mould. The materials are occasionally washed during the process of tempering, such as those used for *washed malms*, which are made with great care. On these occasions the mill is in action, the water being freely admitted, which dilutes the material to the utmost comminution; the soil is then left until required for manipulation, and the water used in reducing it to a pulpy state quickly evaporates upon exposure to the atmosphere.

After the process of moulding, of piling in open rows called *packs*, which are generally covered over loosely with straw, the bricks are left standing for six or eight days until they become dry, care being taken to shift them once or twice to prevent cracking. The best

bricks require more time to dry than common ones, as the material of which they are composed is much closer and finer in its nature. Bricks are generally burned in *clamps* or *stocks* in the neighbourhood of the metropolis; but in many of the country districts they are burned in kilns, which not only require less fuel and save time, but also turn out the bricks in a more compact and homogeneous condition. From the difficulty of regulating the heat in *clamps*, the bricks in certain parts become vitrified, and cling together: others receive so little heat that they are not much better than dried clay. Those, however, which have received the proper degree of heat will be found clean, sound, and well shaped, and are considered the best quality of brick. The first are called *burrs*, the second *place-bricks*, and the third *gray stocks*. Bricks made by machinery are generally heavier than those moulded by the hand, which is no recommendation; the quality must be determined by the nature of the materials and not by the process of making; and the preference given to either process is, therefore, exclusively dependent upon economical considerations.

The brickwork in the neighbourhood of London is superior to any other in the country, with one or two exceptions. The Manchester stock-brick is, perhaps, equal to those made by the metropolitan brickmakers; so also are a few *reds*, which are made in Bedfordshire, and the *white* Suffolk, which, in fact, may be called a London brick, being made but a few miles' distance from it. There are, however, three kinds of bricks made near London. First, the *malms* or *marl-stocks*; secondly, the stocks, or *gray-stocks*; and thirdly, the *place-bricks*; also called peckings, sandal, or samel bricks. Malms have a smooth surface, are a pale yellow colour, and are considered the best in quality. Being also tempered and prepared with considerable care, they possess the greatest durability, and command the best price. These bricks are divided into two classes, the *firsts*, or cutters, which are carefully picked out from the mass, and after being cut and rubbed to the required form are generally used for the best kind of work, such as the arches of doorways, windows, and quoins. The *seconds* are principally used for facing fronts, when superior work is required. The *gray-stock*, which may be termed the standard brick, though not equal to *malms*, ought to possess two qualities; it should be sound in body and pale in colour, and the nearer it approaches stone in the latter respect the better. There are also *red-stocks*, which are burned in kilns, and generally consumed in the country, the grays being preferred in London. The *place-bricks* are those placed on the outside of the

clamp, and are not so well burnt as others; they are consequently of a much softer nature, and not so even in their colour. The vitrified, or over-burnt, bricks are called *burrs*, or *clinkers*, and are used for the commonest work.

There are one or two other kinds of bricks, which are used for special purposes, such as the fire bricks, the Dutch and Flemish bricks, and the clinkers, the last three being imported from Holland and Belgium, which ought to receive a passing notice, however limited may be their consumption in this country. The *fire-brick* is made of Hedgerley loam, or Stourbridge clay, and is indispensable for certain purposes. The peculiar excellence of these materials consist in their being able to endure the greatest heat without injury. When properly prepared in the shape of bricks, they are generally used for ovens, furnaces, glass-houses, and other structures where extreme heat is required. The foreign bricks alluded to, which the Chancellor of the Exchequer has just relieved from a considerable duty, are very hard, and of a dirty brimstone colour; in some instances they resemble our gray-stocks, but they are mostly of a yellower colour. The Dutch are generally the best baked, and the Flemish the yellowest in appearance. The clinkers are extremely hard, and are sometimes used for ovens; the others for paving yards, stables, and other ordinary purposes.

The red cutting-brick, or fine red, which is the finest of all bricks, must not be confounded with the red-stock; it is frequently used in arches and cornices, and when ruled, and set in putty, it presents the most beautiful appearance of all brickwork. It is, also, much the most costly. Care, however, should be taken not to admit the red brick into front walls of buildings, especially where stone work is used, for the colour is not only disagreeable to the eye, but it has an appearance of heat in summer, which is anything but pleasing. In addition to these disadvantages, wherever stone is used with brick, the contrast between the colour of that material and the fire-red is so violent that the harmony which ought to prevail on a given surface with different contrasts is completely destroyed. The gray-stock, approximating the nearest to the colour of stone, is generally and justly chosen for such purposes in preference to the fiery red brick in question. The place-brick is commonly used in paving dry, or laid in mortar, and is laid down flat or edgewise; if flat, thirty-two of them pave a square yard, and if edgewise it takes twice that number. In the front work of walls place-bricks should never be admitted, however mean the building; and gray-stocks should always be preferred, even before the

red-stocks, if durability and good work are to be ensured. Yellow malms, as they are called, are more porous than stocks, and soon become black in appearance, the rain and smoke much more readily adhering to them than to those of a smoother surface and a more cohesive quality.

The hollow or tubular bricks, which are somewhat largely in vogue since the Exhibition of '51, where their peculiar excellence was pointed out in more ways than one, are deserving of especial notice in a work devoted to the subject of building, however humble may be its nature or unpretending its general spirit. Although the idea of using hollow bricks in certain structural purposes is by no means new even to the present age, for they are commonly used in Tunis and in Egypt, where they have been uniformly in requisition from the most remote period, and the Romans are known to have used similar materials when lightness of structure was required—still they present themselves to us in comparatively so new a light, and suggest a practical remedy for more than one defect in structural art, that they are fully entitled to a minute examination, in order that their peculiar excellence may be properly appreciated.

First, then, as to their form. One kind is made wedge-shaped so that they are banded longitudinally over each other, two cavities running parallel through every course, which prevents moisture by giving greater facility for ventilation. This shape, however, is not considered the best for securing the ends desiderated, and as there is apparently a judicious analysis of the shape, the quality, and the peculiar advantages of the best kind now in use, in a work * of justly-considered weight and authority, we shall avail ourselves of it on the present occasion:—

The dimensions being unlimited, a size has been chosen which, with the omission of the headers, reduces, by about one-third, the number of joints, and greatly improves the appearance of the work, giving it more boldness of effect and resemblance to stone than that of ordinary brickwork. This size is twelve inches long, and three courses rise one foot in height, a size equally convenient for the workmen in the manufacture, and in the use of the bricks—for whilst less liable to damage in moving than those of larger size, their form admits of ready handling and stowage for transport.

Nine patent hollow bricks of this size will do as much walling as sixteen of the common sort, whilst the weight of the former but little

* Reports of the Juries of the Great Exhibition of 1851.

exceeds that of the latter—an important consideration in reference to carriage as well as the labour in using. When passing through the machine, or in the process of drying, any number may be readily splayed at the ends for gables, or marked for closures, and broken off as required in use; or they may be perforated for the purpose of ventilation. If nicked with a sharp-pointed hammer, they will break off at any desired line, and the angles may be taken off with a trowel as readily as those of the common make.

A sufficient proportion of good facing bricks may be selected from an ordinary burning, and in laying them a much better band will be obtained than is usually given in common brickwork. The bricks for the quoins and jambs may be made either solid or perforated, and with perpendicular poles, either circular, square, or octagonal. Those in the quoins may be so arranged as to serve for ventilating shafts. Stone will be found equally applicable for the quoins and jambs, and the appearance of the work be thereby improved. Hollow bricks may be made with any good tile machine, in the same manner as ordinary draining pipes, and at about the same cost, in proportion to the quantity of clay used in them. They are more compressed, require less drying, and with much less fuel are better burned than ordinary bricks, even when only waste heat, or that in the upper part of the kiln, is used.

On the score of economy alone, irrespective of their beauty and utility, these hollow bricks are deserving of especial notice. Relying upon the authority just quoted, which has been practically confirmed by the observation of the writer on more than one occasion, the saving may be effected in the following manner:—On the cost of making there is a saving of from 25 to 30 per cent., as compared to other bricks; and on the quantity of mortar required for their use, to say nothing of the economy of labour employed, a similar result is obtained. The process of drying is also much more rapid than in common brickwork, and the smoothness of the internal surface of walls built by these bricks renders plastering in many instances quite unnecessary.

The following statement, however, will place the matter in a clearer light than a whole page of comment; we shall therefore make no apology for placing it before the reader:—

Statement showing the comparative cost of a rod of reduced brickwork, built with ordinary bricks of the common size, and a rod built with patent bonded hollow bricks:

	£	s.	d.
4,300 ordinary bricks to a rod, at 20s.	4	6	0
2,450 patent bonded hollow bricks at 25s.	3	1	9
Saving in bricks per rod	1	4	3
4,300 ordinary bricks to a rod, at 24s.	5	3	3
2,450 patent bonded hollow, at 30s.	3	13	6
Saving in bricks per rod	1	9	9
4,300 ordinary bricks to a rod, at 28s.	6	0	5
2,450 patent bonded hollow, at 35s.	4	5	9
Saving in bricks per rod	1	14	8

Here, then, it is clearly shown that an advantage is obtained by using hollow instead of ordinary bricks, and that a saving of 30 per cent. may be made in favour of the former. There is, also, a diminution in the cost of transport, and fully 25 per cent. less of mortar and labour required for the same surface of work. The hollow bricks * are calculated in the statement at an average of 32s. per thousand, and the common at 18s., the difference arising principally from the one being much larger than the other.

BRICKWORK.

In all buildings where a vertical pressure has to be sustained there ought to be kept in view three principles. First, uniformity of structure throughout all its parts; second, the bonding the work firmly together; and, lastly, the proper distribution of the weight to be borne. As regards the first principle, it may be remarked that it is not so much the *amount* of pressure as the *irregularity* which affects the stability of structures. The whole of the walls, therefore, of buildings should be carried up as nearly at the same time as possible, and no portion should be allowed to exceed the others, by four or five feet in height, as a shrinkage is sure to take place, the extent of which will very much depend upon the quality of the materials used. In these instances, the part first formed settles before the remaining portions are made level with it. Porches, and other projections, should be added, for the same reason, when the building is roofed in, as they are subject to unequal settling if built at the same time. The mortar

* The fact of bricks being, at the present time, nearly double the price quoted in the text, does not alter in the slighest degree the relation between the two kinds.

should be used quite fresh and as stiff as possible, which gives it a more binding quality, and the bricks should be dipped in water as they are laid, and well bonded together, especially in dry weather. Where cements are applied the shrinkage is less, which causes that material to be used in adding to, or repairing buildings.

The tops of the walls, when building, should be covered over with straw, or weather boarding, when left for any length of time; and during frost all building operations should cease, as there is no greater destruction to bricks and mortar than the elements when they are in that condition. No brickwork in the course of structure can resist the effects of frost and rain unless it be safely protected.

As the strength and durability of a structure mainly depends upon the *bond*, or the mode of laying on the bricks, it may be as well to point out the difference between the two kinds in general use.

The bricks having their lengths in the thickness of the walls, are termed *headers*, and those which have their lengths in the opposite direction, or at right angles with the first, are called *stretchers*. The laying of bricks in a wall, of which every alternate corner consists of *headers*, and of which every corner between every two nearest courses of headers consist of *stretchers*, is called *English bond*. The laying of bricks in a wall (except at the quoins) and of which every alternate brick in the same course is a *header*, and of which every brick between every two nearest headers is a *stretcher*, is called *Flemish bond*. The *English* bond, therefore, is a continuation of one kind throughout, in the same course or horizontal layer, and consists of alternate layers of headers and stretchers, the headers serving to bind the wall together longitudinally, and the stretchers to prevent the wall splitting crosswise, or in a transverse direction. Of these two evils the first is the most feared, and is of the worst nature. The *Flemish* bond is considered to have the neatest appearance, and is always preferred by workmen, from its being more readily worked; but as the number of headers is fewer than in the *English* bond there is not so much lateral tie, and on this account it is considered inferior in strength. A common fault, which ought to be strictly guarded against, is that of building brickwork with two qualities of brick, which invariably destroys the bond between the back and front of a wall. In these instances the headers of the facing bricks are cut in two, to make the better material go farther, which leaves an upright joint between the facing and backing of the work. The *Flemish* bond was introduced to this country in the time of William and Mary, with other Dutch fashions, and our workmen are so infatuated with it,

that the old English bond is scarcely ever worked, although it is much superior in strength, from its requiring a more truthful amount of labour. Brickwork is measured in London by the rod, and was taken from the original standard of 16½ feet cube, which gives 272·25 square feet or 272¼ square feet of brickwork, 1½ brick (13½ inches) thick, as the superficial contents of one rod of reduced brickwork. The quarter foot is not noticed in practical measurement. The standard thickness of a brick wall being 13½ inches, there are consequently 306 cubic feet in one rod of brickwork, which requires about 4,500 bricks, including waste, the number, however, varying with the closeness of the joints and the size of the bricks. One rod of brickwork requires 1½ yard of chalk lime, or 1½ yard of stone lime, and 2½ yards of sand with stone lime, or 2 yards with chalk lime, for the mortar. One bricklayer can lay 1000 bricks per day in common working, with the aid of a labourer, so that he will complete a single rod in 4½ days, allowance being made for apertures and adjustments.

One foot of reduced brickwork takes 17 bricks.

One foot super. of make-facing, laid in Flemish bond, requires 8 bricks.

One foot super. of gauged arches requires 10 bricks.

One cubic foot comprises 125 bricks, or 95 lbs. of sand, or 135 lbs. of clay, or 124 lbs. of common earth.

Three hundred and thirty bricks, or 23½ cubic feet of sand, or 17½ of clay, or 18 of earth, equal to one ton weight; one cubic foot of brickwork weighs 120 lbs., and one rod of fresh brickwork 16 tons.

Brickwork in the country is generally measured by the yard; and in engineering works the same measure is adopted. There are 11½ cubic yards in a rod.

As regards the distribution of weight, the last great desideratum in brickwork, it can only be secured by converting good materials into good work, which very rarely occurs. Bad bricks, bad mortar, and bad workmen, all of which more or less prevail in our structural elements, are, however, of too common occurrence to expect such a result, therefore we must jog on as well as we can, and content ourselves with pointing out the right way, in the hope that it will be more frequently followed than the rickety state of many of our buildings would seem to indicate. The following remarks, therefore, on this head will be read with interest, as they bear the impress of practical experience, and are the result of a disciplined observation:—

"It is a remarkable fact, that in proportion as the manufacture and burning of bricks have improved, and while the use of stone-

lime has become more general, the workmanship of much of our modern English brickwork has debased in quality more than the materials of the work have improved. The writer is obliged to confess, that although he has taken very great pains to procure complete soundness in the execution of brickwork, he has almost wholly failed; his idea of soundness is nothing more than that the work should be composed of good materials correctly bonded in every part, should be thoroughly cemented together, and that as few broken bricks as possible should be used in the work. When you deduct from brickwork in ordinary buildings the loss of strength occasioned by badness of material, by disconnection of the bond, by small pieces being inserted where whole should have been used, and by the weakness which is the result of the work not being duly cemented, you will find that the useful part of common work executed at £10 per rod, really costs £50 or more per rod; and then, when it is considered, in a vast number of our erections, that from one pier not being set over another, a large portion of such piers, instead of supporting the superincumbent weight, act as ruinous burthens upon the remaining parts of the pier, it will be found that the quantity of effective brickwork is often so reduced as to cost more than £100 per rod; and indeed it is almost a mistake to say that any of it is effective, while in jeopardy from defective nature and mal-construction." *

The same writer remarks further on, in perhaps a somewhat too sanguine spirit, that the public have the remedy for defective brickwork in buildings in their own hands; or, rather, that the public simply require to be instructed upon the false economy of tolerating bad work, and it will be at once discouraged in the most effective manner. However we may differ in opinion with the writer on this head, we shall endeavour to contribute our mite of instruction towards the better understanding of the public; and to carry out this view we think we cannot do better than quote the words of the writer himself:—

"Only practically convince the public," he says, "that economical soundness, internal capacity and duration, may be obtained by the proper use of proper materials, and the coarse and slovenly workman will in vain attempt to defraud his employer by the sale of large quantities of worthless materials; the brickmaker will find a mode of protecting his goods, while crude, from the injuries of inclement weather; and he will so well burn his bricks, that no more soft ones will be in the market that can be used for mere purposes of bulk and

* Bartholomew's Specifications for Practical Architecture, p. 356.

weight, or for the repairs of inferior buildings, the great duration of which is of comparatively little consequence."

When this millennium in brickwork shall take place, we may hope to have better foundations for our houses, and the superstructures carried up in a more workmanlike manner, so as to secure a larger amount of comfort and convenience for the inmates. The chimneys will then, we trust, not smoke so disagreeably; nor shall we find the workmen leaving so many *flues* in the walls to save labour, which are mostly the cause of the unsightly cross-strains that so frequently offend the eye.

CHAPTER VII.

STONES AND STONEWORK.

STONE is generally considered to be superior, on the whole, to any other material for building. This is owing to its great durability and solidity, both in aspect and in reality; and to its requiring little or no trouble to keep it in repair, as it suffers but little injury from the action of the elements.

The stones employed for building purposes in this country are mostly of the oolite formation. The three principal oolites used are the Portland, Bath, and Caen. This kind of stone generally comprises silica, alumina, lime, and magnesia, together with some small portions of metal combined with acids, water, and sometimes with the fixed alkalies and other matter. Stones are classified generally under three heads, though the component parts of some stones partake of each class, namely, *siliceous*, which is the most durable, and least subject to external influence. The granites and sandstones are ranged under this head. The second, or *argillaceous*, comprehends the basalts, or whinstones, as they are commonly called, to which must be added the slate stones. The third, or *calcareous*, is the most plentiful, and perhaps the most useful class of stone, and comprises the limestones, from marble downwards.

The subject of the durability and decay of building stone is but imperfectly understood by what are called practical men, or builders, as the inequality of preservation in the same building frequently attests, although the stones have been all obtained from the same

quarry. The decomposition of the stone is effected both by chemical and by mechanical means. These can be obviated, to a certain extent, by setting the stone according to its natural inclination in the quarry, which renders it less pervious to the atmosphere, and by fitting it evenly in its position, which will prevent any irregular settlement or subsidence. Practical experience of the highest order, moreover, suggests that all stone, particularly soft freestone, should be laid upon the walls in what is called its natural, or quarry bed, parallel with the horizon; and when a stone is enclosed on each side, it must be set with its lamina perpendicular to the face of the wall, as it cannot then flake off through exposure to the atmosphere or frost. Stone will also bear a much greater weight when laid in its quarry bed, than in any other position. The church of St. Phillip, Birmingham, is a remarkable instance of the stonebeing injudiciously laid; almost all its surface is flaking off, as though it were afflicted with a species of leprosy.

Yet this is a common error in other of our superior structures, and clearly denotes that the intelligence of our architects is confined within a very limited range; and it would be as well, perhaps, for the rising generation of that class of useful industry to mingle with their ordinary acquirements a little more of geological and chemical science, for both will throw a flood of light upon the nature of the materials which commonly come under their observation, and enable them not only to diminish the amount of their labour, but also to materially improve its quality. These desiderata, it is almost needless to observe, are of the utmost importance to builders, architects, surveyors, and others who are in any way connected with structural purposes.

The *granites* are principally used for engineering purposes, and for forming our highways. The essential ingredients of this hard and siliceous stone are felspar, quartz, and mica, which are irregularly disposed through its whole body. Grey granite is more generally employed than red, which is difficult to work, from its extreme hardness. Aberdeen granite is preferred to Cornish, as it contains more quartz, while in the latter felspar generally predominates, which is more perishable, from the potass in its composition. The granite, however, which is now principally used in the best paving, comes from Ashby-de-la-Zouch, in Leicestershire, and is found to be tougher and more durable than any hitherto tried. It is used principally in the metropolis, and is of a much redder hue than the Scotch. London Bridge is built of Aberdeen granite, and Waterloo of the best Cornish. The

surface of these stones will respectively exhibit the effect of the atmosphere upon them.

The *sandstones*, when of good quality, are found to be durable materials for building purposes. They are composed of grains of sand agglutinated together by a natural cement; the grains are sometimes exceedingly fine, at others very coarse, forming what are termed conglomerates and pudding-stones. The Craigleith is one of these stones, and is extensively used in Edinburgh for the construction of its buildings; and the Stancliffe, or Darley Dale stone, which is much used in the Northern and Midland Counties, fully equals it in quality. The latter contains from 93 to 98 of silica, and from 1 to 2 of carbonate of lime. The Purbeck-stone is also a sandstone, but much coarser than the two just mentioned. When great strength is required, it is commonly used; and the greater portion of the steps, pavement, and other rough work of the metropolis, is made from this stone. It soon, however, loses its colour.

The *blue lias* stone, which is common in many parts of England and Wales, is not much used for building; it is more serviceable for concretes, and all works connected with water. The *whinstone* is equally unfit, being much too hard for masonry purposes. It is a hard, argillaceous, and close-grained stone, of a bluish colour, and is found in irregular masses in the beds of rivers. For cements it is found a useful ingredient.

The *limestones* are most in requisition for building purposes.* The magnesian limestone, found in the quarries near Balsover, in Derbyshire, is a stone of great beauty and value, and remarkable for its great durability, at least in those parts of the country in which it is found. The commissioners appointed to determine upon the best stone for building the Houses of Parliament, selected the magnesian limestones, on account of their more general homogeneous structure, and the facility and economy of their conversion to building purposes: though the commissioners acknowledged that several sandstones,

* Limestones used for buildings are classified into three—first, the pure limestones, which contain from 79 to 93 of carbonate of lime; secondly, the oolite, containing about the same quantity; and, thirdly, the magnesian limestone. The Balsover is at the head of this class, and contains 51·1 of carbonate of lime, 40·2 of carbonate of magnesia, and 3·6 of silica. The cohesive powers of this stone are upwards of five times as great as the Bath oolite. It requires 296·01 cwt. to crush a cube 2 inches square of the former. An admixture of silica is very advantageous; thus the Chilmark limestone possesses 10 per cent. of silica, and consequently rises almost equal to the Balsover in point of cohesion, and is superior to it in non-absorbent properties.

equally with limestone, possessed many advantages for building, still they preferred the Balsover Moor stone as the fittest material for their especial purpose. The crystalline character of the stone, with its equivalents of carbonate of lime and carbonate of magnesia, and its uniformity of structure, which made it easy to be worked, are qualities which no other stone presented in the same degree. In addition to these advantages, it possesses a good colour, and preserves it for a long period.

The *Caen-stone* is well-known, and has been extensively used for centuries. The rock is an oolite, of about the same period of formation as our own oolites, worked near Bath; but the colour is better, more uniform, the texture much closer, and the material superior in every respect. This stone is at first absorbent, but improves on exposure. It cuts with perfect facility, and is thus well adapted for ornamental work in architecture, especially when sheltered from the weather. For certain kinds of exposure it is, however, inferior to some of the English oolite stones, though none excel it for internal work.

Bath-stone, so well known as a building material, is, perhaps, the most inferior of all the oolites. It is, nevertheless, in great vogue for certain purposes, from the facility with which it is worked, arising from the softness of its nature, especially when fresh from its native bed. It hardens, however, by time; but it is incapable of resisting an English, much less a London atmosphere. The colour of Bath-stone soon becomes dark and disagreeable, after a lengthened exposure to the atmosphere; in texture it is seamy and coarse; and it is of such a porous and fragile nature that it very quickly decomposes, and deforms the structure of which it is built.

Portland-stone may be designated as one of the best, if not the best, of the calcareous oolites for building purposes. It was formerly much more used than it is at present; so many quarries in different localities, and much more easy of access, having supplied the wants of our architects. When quarried, this stone is soft; but it quickly hardens on exposure to the atmosphere; yet a great deal depends upon the bed whence it is derived, there being so many qualities of what is called Portland. The Portland beds are a marine foundation, occurring in the island of Portland, and in Wiltshire. These beds consist of coarse shelly limestone, fine-grained limestone, and compact limestone, with a mixture of chert, having throughout an oolitic structure. The quality of the stone, therefore, greatly depends upon the several proportions of the preceding ingredients which it may

contain; and as they are anything but uniform in their distribution, the stone is naturally unequal and irregular as to its compactness and structural durability. The outer-front of Somerset House, which is still of a beautiful colour, in spite of the dun and smoky atmosphere around it; and the towers and parapet of Westminster Abbey, which contrast so favourably with more recent work of different stone, amply testify to the superior and enduring quality of the Portland stone, when judiciously chosen, both as regards its texture and its colour. There is, however, an objection to it, on the part of workmen and builders, from its requiring more labour to turn it into a proper structural condition than several other stones; and this objection has materially restricted its use, to the great detriment of isolated buildings, and to the diminution of the architectural beauty of the metropolis.

The Portland stone, as we have already remarked, was formerly in general use in the metropolis. St. Paul's Cathedral, and the churches designed by the same great architect, are all built of this material. It was also commonly used for steps, window-sills, copings, strings, balusters, and most ornamental work in buildings; but it has been greatly superseded by Bath and Purbeck in these several applications.

The pressure which stones will bear differs according to their quality, as the following statement, which is the result of practical experiment, clearly shows:—

	lbs. per cubic foot
A cubic foot of Aberdeen granite, weighing 164 lbs., will bear a pressure of	196,000
A cubic foot of Cornish granite, weighing 166 lbs., will bear a pressure of	114,000
A cubic foot of Bromley Fall stone, weighing 157 lbs., will bear a pressure of	109,000
A cubic foot of Portland stone, weighing 132 lbs., will bear a pressure of	30,000
A cubic foot of Bath stone, weighing 123½ lbs., will bear a pressure of	17,000

The weight of a cubic foot of rubble-work is about 140 lbs., and of hewn stone 160 lbs. The pressure borne by piers, and supports of large building, varies according to their height, and the size of the supports. The pressure on the piers of St. Paul's Cathedral is estimated at 39,000 lbs. on each superficial foot, and in some buildings it is much greater.

STONEWORK—MASONRY.

STONEWORK, practically considered, is the art of shaping and uniting stones for the various purposes of building. This is the province, properly speaking, of the mason. Masonry, therefore, includes the hewing of stones into the several forms required, and the uniting of them, either by joints, level, perpendicular, or otherwise. In the union of stones the mason requires the aid of cement, iron, lead, or some other material; but mostly these. The quality of the stones—the common material of masonry—is described in the preceding chapter.

Masonry may be divided generally under three heads, each of which is known by some technical term expressive of the manner in which the stone is worked.

First, *plane ashlar*, or cut masonry, in which each stone is squared and dressed to certain dimensions. The cutting, or working, upon the several faces and beds of stones, is called *dressing*, and these stones are said to be *wrought*. In the best description of work, the stone is rubbed smooth, when it is called *plane ashlar*, although the term is sometimes applied to an inferior kind of work.

Second, *hammer-dressed*, which is applied to masonry when the stones are merely squared and picked by the hammer, which is generally the case with hard stones. The term, however, applied to hewn work of the commonest description, is *broached;* and when the surfaces of hard stones are worked in parallel perpendicular flutes, it is termed *tooled* or *droved*. When the tooling is worked irregularly, it is described as *random tooled;* and when the stones are worked by a narrow tool or chisel, it is called *boasted* or *chiselled*. Sometimes the surface is nicked or cut with a small tool, when it is said to be *pointed;* at other times it is *droved* and *broached*, and also *droved* and *striped*.

Third, *rubble*, or rough masonry, of which there are several varieties; the ordinary consists of merely using the stones on the face, and laying them according to circumstances.

Ashlaring consists in applying stones, cut to certain dimensions, to the facings of buildings, which ought to be well bonded and cramped together with copper cramps—iron corroding, and otherwise injuring the stone. The *ashlar* stones are generally cut the size of from three to four courses of brickwork, and bonded with headers and stretchers after the Flemish bond; but the courses should not be too high, and the joints should be crossed regularly, which would improve its appearance, and add to its solidity. In ashlar masonry the stability of the work is independent, in ordinary cases, of the mortar; and in dressing

the beds of ashlar-work, care should therefore be taken not to work them hollow, or the pressure will be thrown upon the edges of the stones, which will be sure to end in unsightly fractures. Ashlar-facing, however, is seldom employed where great strength is required, as the backing is apt to sink more in the settling than the ashlar, which causes the work to disunite and become weak; this defect is somewhat lessened if the backing consists of stone, but it is by no means removed. The only possible way to remedy a defect of this nature is to set the backing in good strong cement, or some hard and quick-setting mortar. It is likewise advantageous to have the back of the ashlar irregular, or not parallel with the front, but projecting with some of the stones and receding with others; by this means a firm bond is more likely to be formed with the backing, and a closer union, which cannot fail to increase the strength of the structure. *Thorough* stones should also be occasionally introduced.

Rubble-work is rough masonry in which the stones are used according to the notions of the workman, with little preceding preparation. The stones are generally laid in as regular courses as possible, and well flushed with mortar. Bonders are occasionally inserted, running through the entire thickness of the wall, to tie the whole together, which is found almost indispensable. Chain-bond is also used in rubble-walls with great advantage, if many openings are required to be left. The stones, however, in good work, are as large as the workman can conveniently lift. When the stones are laid in regular courses, the work is called *regular coursed*; when the contrary, *irregular coursed*; the stones in each case being regularly gauged, and dressed with a hammer. When the stones are not laid in courses, but merely piled or laid one upon another, the work is termed *random* or *uncoursed* rubble; and the only preparation the stones undergo is that of knocking off very sharp angles. Clay, burnt into a kind of brick-rubble, makes excellent stuff to introduce into work of this kind, while scaling slate ought to be studiously avoided as the worst material.

In the building of our walls, we have followed, in most instances, the methods adopted by the Greeks and Romans, with, perhaps, one important exception—they are not so solid and compact as those of the ancients. The ancients used several sorts of walls, in which more or less masonry was always introduced. The *reticular* wall, in which the joints are so ordered that the courses have throughout an inferior position, is considered the most handsome; while the *incestain*, in which the materials rest firmly upon each other, and are interwoven together, was considered the stronger. In the latter wall the courses,

however, were always level, though the upright joints were not ranged perpendicularly to each other in the alternate courses; but in both kinds of walls, though frequently composed of small pieces, an abundance of good mortar was used, which gave them compactness and solidity.

The walls of modern buildings are mostly built for ornament, and are seldom very solid. In the metropolis they are regulated by a specific act of the legislature, which was framed to obviate the destructive effects of fires; but, to prevent dilapidation, it is necessary to strengthen the walls beyond what the law requires, which is very seldom done. The thickness of walls should be regulated according to the nature of the materials and the magnitude of the edifice. Walls of stone may be made one-fifth thinner than those of brick; and brick walls, in the basement storeys of first-class buildings, should be reticulated with stones to prevent their splitting—a circumstance too frequently neglected.

Stone bonds should always be used in masonry in preference to wood, which is liable to shrink and cause an unequal settlement, or to decay, which is equally injurious to the beauty and strength of a building. These stones should be carried through the thickness of the wall, so as to tie the several courses together. They ought always to be placed above and below windows; and when the jamb is formed of a single stone, which is always the case when mouldings are wrought upon it, the last stone next each jamb of every alternate course should always be a *thorough* stone. If the jambs are composed of coursed stones, then every alternate stone must extend through the thickness of the jamb. Bond-stones are sometimes formed wedge-shaped in the thickness of the wall, or, in other terms, their vertical joints are made with a close joint for about three-quarters of an inch from the face, and then gradually widened; this plan of setting the stone is generally accompanied with heading-stones. In rubble-work bond-stones are essentially necessary, particularly uncoursed rubble; and in these cases the stone should be of large dimensions, and extend through the entire thickness of the wall.

Instead of bond-stone or timber, hoop-iron bond has now crept into use. This is formed of iron hooping, tarred, to protect the iron from the corrosion of the mortar, and laid in the thickness of the mortar-joint. Could iron be preserved from corrosion, which is impossible wherever dampness prevails, even in the slightest degree, it would form a good longitudinal tie, and be certainly preferable to timber, but not to stone.

Pinning-in is also necessary in stone walls. It consists in filling the joints in stone walling with small pieces of stone, when the blocks are of an irregular shape or imperfectly squared.

When a heavy pressure has to be sustained on a few points, as in the case of a large floor resting on girders, the weight should be brought as nearly as possible on the centre of the wall; and to distribute the weight effectually over a large bearing surface, the wall should be stone-bonded through its entire thickness.

The apertures for doors and windows on each floor ought to be so arranged that openings should be over openings, and piers over piers, which is generally a safeguard against settlement. As the pressure, moreover, on the foundations is always the greatest under the piers, it is necessary to connect them with inverted arches, which has the effect of distributing the weight over the whole surface of the foundations. The several openings in the walls for doors, windows, and gateways should also be arched over throughout its entire thickness; and wooden lintels should only be introduced as ties to counteract the thrust of the arches, and as attachments for internal finishings.

Cast-iron brestsummers have recently been introduced for supporting the wall over large openings, especially in shop-fronts; there is, however, a serious objection to them, for in case of fire—especially if water be thrown upon them in a heated state—they are almost sure to break short, and cause a greater loss than timber would do in the same position.

ORNAMENTAL STONEWORK.

Strictly speaking, ornamental masonry does not fall within the limits of this little work, which is simply suggestive of a few facts and hints that a comfortable and well-to-do man, who has a fancy and taste for building, may turn to some account. We do not aim at illustrating the art of building in its highest departments, nor at throwing any new light upon the application of the five orders; there are works almost without number, in which these matters are more appropriately, and unquestionably much more ably discussed than we can have any pretension to. We are simply desirous of having an agreeable half-hour's chat with the reader, who may take a fancy to indulge in the instructive pastime of building his own house, and who does not please to appear thoroughly ignorant of the matter he is about. The mystery connected with bricks and mortar—with stone, timber, and cement—is not so profound, after all, as the worthy dealers in these commodities would fain occasionally make us believe;

nor is the convenience, the propriety, and even the beauty of a good design beyond the comprehension of an uninitiated architecturist. Humbly premising these few observations, we shall, then, enter briefly into a description of certain portions of ornamental masonry; but shall confine ourselves to those which are strictly suitable to ordinary structures, and which are, in too many instances, strangely caricatured and misplaced.

Leaving columns, pilasters, and architraves to their fitting associations, we shall therefore commence with *parapets*, seeing that they are indispensable in a certain order of buildings.

Parapets are considered ornamental to the upper part of an edifice, and were occasionally used by the Greeks and Romans. They are composed of three parts:—the plinth, which is the blocking course to the cornice; the *shaft* or *die*, which is the part immediately above the plinth; and the cornice, which is on its top, and projects sufficiently in its moulding to carry off the rain-water from the shaft and plinth. Parapets are regulated by the Building Act in and around the metropolis; and vary in their thickness and height according to the first or second-rate character of the building. In first-rate dwelling-houses the parapet is 13 inches thick, and 12 inches above the highest part of the gutter; while in the second-rate they are 8½ inches thick, and 12 inches high.

Cills belong to the apertures of the doors and windows, at the bottom of which they are fixed, their thickness varying according to the character of the structure, but commonly about one inch and a half. They are sunk in their upper sides, and fluted in their under edges, add in general project a couple of inches beyond the face of the wall.

Cornice forms the crown of the ashlaring at the summit of a building; it also marks the particular order of the work, such as *Doric*, *Ionic*, *and Corinthian*. In working the cornice, the top or upper side should be splayed away towards its front edge, that it may more readily carry off the water. At the joint of each of the stones of the cornice, that part which comes nearest to it should be left projecting upwards a small way, to prevent the rain-water from entering, and to wash out the cement. These joints should be chased and filled with lead, whether dowels are used or not.

Rustic, or Rusticating, consists in forming horizontal grooves in the stone ashlaring of an elevation, intersected by vertical or cross ones. It is sometimes formed by splaying away the edge of the stone only; in this style the groove forms the elbow of a geometrical square. Many builders omit the vertical grooves in rustics, so that the wall

simply presents a series of horizontal sinkings. The joints in rustic work are sometimes formed in imitation of ice, and hence called frosted; at others with an appearance like wood that has been destroyed by the worm, which is called *vermiculated*. Stonework left rough without tooling, is also called *rustic work*.

Blocking-course is a course of stone traversing the top of the cornice to which it is fixed; it is commonly in its height equal to the projection of the cornice. It is of great utility in giving support to the latter by its weight, and to which it adds grace. At the same time it admits of gutters behind it to carry the superfluous water from the covering of the building. The joints should always cross those of the cornice, and should be plugged with lead, or cramped on the upper edges with iron.

Fascia is a plain course of stone, generally about one foot in height, projecting about an inch before the face of the ashlaring, or in a line with the plinth of the building; it is fluted on its upper edge to prevent the water from running over the ashlaring, its upper edge is sloped downwards for the same purpose. It is commonly inserted above the windows of the ground storeys, that is, between them and those of the principal storey.

Plinth is the first stone in masonry inserted above the ground. It is in one or more pieces, according to its position, and projects beyond the walls above it about an inch, having its projecting edge sloped downwards to carry off the water that may fall on it.

Imposts are stones inserted with their front faces generally moulded; when left plain, they are prepared in a similar manner to fascias. They form the spring-stones to the arches in the apertures of a building, and are of the greatest utility.*

CHAPTER VIII.

TIMBER, AND INTERIOR DECORATIONS.

As timber is largely used in almost all buildings, and as no building can very well do without it, it may not be irrelevant to our purpose to make a remark or so upon that material.

Authorities differ as to the time that timber should be kept before

* Vide the "New Practical Builder and Working Man's Companion," Kelly, 1823.

it is fit for use; but all agree that it ought to become thoroughly dry and well seasoned, and that the old plan of damping it by allowing it to float in water till it was nearly required for use is completely exploded. The reason is obvious. The drier the timber and the more free from sap the stronger it is; and the converse holds equally good—the more sappy it is, and the more swollen with water, the weaker it becomes, and the sooner affected with decay. Formerly the timber used for building purposes was kept immersed in docks; the consequence was that it became swollen beyond its natural dimensions, and when framed in that condition it soon shrunk to such a degree that every tenon became loose, every joint began to shrink, and every ceiling and quartered partition quickly cracked by the diminution and distortion of the wood. After three years have elapsed, timber is now considered fit for building purposes, being dried, seasoned, sawn, and piled.

Timber that is straight in the grain is the strongest; when cross-grained and full of knots it is commonly found to be not only weak but difficult to work. Crooked pieces of timber, in which the fibres are curvilinear, are generally prepared for knees and other similar positions, while heavy timber is considered stronger than the lighter qualities. We have not space to point out the causes of these peculiarities in wood, otherwise we might dwell upon the phenomena which trees present at certain seasons of the year, and during their growth, from the first rising of the sap to the ultimate decay of the stem itself.

Suffice it to state, that the best time to fell trees is either in the middle of winter when the sap has ceased to flow, or in the middle of summer, when the sap is temporarily expended in the production of leaves. The plan generally adopted is to strip off the bark in the spring, and to fell the tree in winter, which has the effect of drying up and hardening the sapwood; but the process is generally applied to trees whose bark is considered valuable.

Three things, however, are essentially necessary to attend to in preparing timber for building purposes—the age of the tree, the time of felling, and the season for use. If a tree be felled ere the heartwood be perfected, the timber will be of inferior quality, and from the quantity of sap contained in it will be very liable to decay. If the heartwood begins to decay, the timber will be weak and brittle; but if the tree has nearly done growing, when it has little sapwood, the timber is always of the best quality.

The seasoning of timber is commonly effected by steeping it, when

green, in water, which dilutes and washes out the sap; after this it is thoroughly dried by exposure to the air. These operations greatly depend upon the size of the timber, or rather the pieces into which it is cut; and for purposes of carpentry two years are generally allowed, while for joinery work a longer time is requisite.

When timber has been properly seasoned it is known to have lasted for hundreds of years without any sensible deterioration; but when not properly seasoned, or exposed to moisture, its duration is exceedingly limited. Paint will sometimes, but not always, protect wood from decay.

There are, however, several artificial processes for preserving timber from decay, each of which has its particular advocates, and generally some specific application. Among those processes, four have especially attracted attention—namely, that of *Kyan*, which consists of impregnating the timber with corrosive sublimate, thus converting the albumen into an indecomposable substance; that of *Burnett*, which impregnates the timber with chloride of zinc, and is found useful, when imperfectly seasoned or inferior wood has to be used; that of *Bethell*, which impregnates wood with oil of tar, containing creosote, and a crude of solution of acetate of iron, commonly called pyrolignate of iron, and is much used in railway sleepers; and that of *Payne*, which impregnates the wood with metallic oxides and alkalies, which become decomposed and form new and insoluble compounds.

The mere seasoning of wood, however, though it will not altogether prevent decay, considerably diminishes its tendency to do so, and is of great importance in many cases; but the value of any particular process is mainly dependent upon the time required for its completion.

The timber in ordinary use for building purposes is varied and numerous. Oak, fir, larch, birch, and poplar are respectively employed; but fir and oak are in the greatest demand and the most generally useful. Very little home-grown fir is used, as European and American firs are esteemed better in quality, and are readily obtained in balks, planks, deals, or battens, at a moderate rate, especially since the duties have been lowered. Fir is in the greatest demand, as it is light, soft, easily worked, and very durable; but it will not bear much strain, except in the direction of the length of the fibres. There is however, no wood which agrees so well with glue; and it will bear greater compression than oak, from the straightness of its fibres, though not so durable, which causes the latter to be chosen for

supports. The pines are employed in almost every part of the building, for plates, timbering, flooring, doors, windows, and fittings generally. The Memel pines are the best for wear, and seldom decay in their bearings; but the Americans are sometimes preferred, as the red of that species cuts up smooth and clean, and is commonly used for what is called smell stuff. The objection to the Memel pines arises, in a great measure, from its coming over in too large pieces, the logs measuring from nine to fourteen feet. Fir that is deprived of its resin is called *white deal*, which, being clean, is the best for internal work, but will not stand the weather.

Oak is the most durable, and the toughest wood, and will bear the strain of a suspended weight better than any kind in use, possessing a much greater degree of tension than others. Where strength is required the English oak is preferred, especially the Sussex, which is hard and fine-grained. Dutch wainscot, which is grown in Germany, is a softer kind, and from that circumstance is not so apt to warp and twist, which makes it preferable to the English oak for joinery work.

The mahoganies, the fancy woods, and the veneers, which are used for a variety of purposes connected with internal decoration, require no observation at our hands, as it would take us far beyond the range of our aim to indulge in any disquisition on that head.

A word or two, however, on carpenters' and on joiners' work, which ought to be done well and truthfully throughout, or the structure of which it forms an important part will be materially depreciated.

We have already remarked that a good foundation is indispensable in a building; otherwise it becomes utterly unsafe, by causing cracks in the walls and partitions, by dragging the floors out of level, and all the openings out of square, and which prevent the doors and windows from acting properly.

The timber used in basement floors, or fixed in the walls, or in any way exposed to the atmosphere, should be yellow deal, which always proves the most durable in such positions. We mean, of course, the Memel, Riga, or Baltic deal; not the American.

The carpenters, if not closely watched, are frequently in the habit of using three-quarter-inch stuff, instead of one-inch, for floors. This is not the only irregularity in their proceedings, to use the mildest term, as they are also prone to put the joists much farther apart than is requisite to impart strength and stability to the basement. Instead of 12 we frequently find the joists 18 inches apart; and in lieu of 11 inches deep and 2½ thick, these said joists are sometimes much less, which soon causes them to become shaky in their condition. Betwixt

the joists of each floor there should also be concrete and rough wood, fitted and filled properly in, instead of being left hollow; when this is the case the rooms are perfectly silent, as the media for conducting sound is thereby destroyed, and the floors are not only more solid, but the ceiling is not so liable to crack, as the wet cannot possibly penetrate through it. If these little matters be attended to, which involve no great cost, the comfort and convenience of the several apartments of a house will be materially increased, and more than one social disagreeable most conveniently obviated.

There is another point, moreover, well worthy of attention, in placing joists properly; they should be firmly strutted in every part to prevent vibration. A slight floor, when well strutted, is firmer and more secure than one of larger scantling without the strutting; and is not so liable to sag in the middle and vibrate with every move, which not only shakes the partitions, but causes the floor to sink away from the skirtings.

Joists of every description, and in every place, ought to be yellow deal; and outside doors and frames should be of the same material. Sashes, and sash-frames, except the inside linings, as well as the sills for the frames, should be made of oak.

Beams should always have a moderate camber, comprising girders, joists, rafters, &c., as the moisture in the timber frequently causes it to sag, merely by its own weight. Girders should be trussed immediately after they are sawn, as the shrinkage and drying are apt to tighten the trusses. The cambering must, as a matter of course, be obtained by force during the operation of trussing, and not by cutting. Timber columns and posts should be bored down the middle, which effectually prevents their splitting.

PAINTING.

The painting in common use is executed in oil, and ought to have at least four coats, if durability be the object aimed at. The workmen, in too many cases, are apt to shirk this branch of building, to the detriment of those who employ them. After knotting the wood, which is the first process, the workman who wishes to deceive his employer mixes a certain portion of size and whitening together, which he rubs over the surface of the wood, to prevent its absorbing the paint. By this means he obtains a smooth surface, and makes in appearance two coats of paint equal to four; but, after a little time, the badness of the work shows itself, and, if exposed to the atmosphere, it quickly flakes and blisters, from having too little body in it.

Another prejudice is entertained by painters in preferring white-lead to the oxide of zinc, simply because the latter costs them a trifle more, in the preparation of their colours; the superior nature of the oxide as an ingredient in the composition of colour, and its being free from the highly deleterious quality of white-lead, are frequently overlooked by workmen, in consideration of the paltry saving which they effect in the first instance.

On the ground of humanity, however, the oxide of zinc ought to be used in mixing colours, if economical considerations did not also strongly recommend it.

PLUMBING.

The plumbing-work in a building requires, perhaps, more looking after than any other portion, if we except the roof and the foundation. The gutters, the roof, the flats, the pipes, the water-closet, the cistern, and the pump are all under the jurisdiction of the plumber; and by scrimping the lead, besides other little injurious devices, he frequently entails upon the owner of a house a vast deal of inconvenience. It is a common practice, amongst this class of workmen, to substitute thin pipes, where the lead is not seen, which are almost constantly out of repair, and to put in for a foot or so at the end a piece of pipe of good thickness, as though the whole length were of the same substance. The same remark may be applied to the linings of cisterns, which are much thinner at the bottom and sides, than towards the top, which more immediately meets the eye. The reason is obvious: lead is a valuable metal, and the workmen know it. It is, moreover, immediately convertible into money, and there are few workmen who can abstain from making what is called "waste," or, in other words, can desist from scamping their work.

NEW MATERIALS FOR BUILDING PURPOSES.

Amongst the new materials for building purposes, which the industry and ingenuity of man have produced, must be classed the enamelled slate.

By means of a new and simple process, Mr. Magnus, of Pimlico, has succeeded in producing works of singular beauty and importance, which are calculated to ensure the introduction of slate for household purposes on a very extensive scale. The advantages of this material consists in its great strength, its lightness, as compared with that of marble, and its adaptability to all kinds of artistic decoration at small cost.

With regard to the strength of slate, it is computed to be about four times that of ordinary stone, and slabs eight feet long and upwards can be very safely used of thicknesses not exceeding half an inch. The extreme compactness of the material, and its perfect non-absorbent qualities, render it well adapted as a lining for walls, where it may be placed without even plastering. In this respect it is preferable to any kind of cement. In its decoration, the exact method of laying on the colour is not communicated; but the slate, after being coloured, is exposed for several days to a temperature of from 300° to 500° Fahr., and the colours are thus rendered so permanent that washstand-tops and other useful articles may be made of it. From its smoothness and its fine texture this prepared slate is adapted for a variety of ornamental purposes; and for chimney-pieces, table-tops, pilasters, skirtings, sideboards, and other like appliances, there is scarcely a material to equal it, as the price is so much less than that of the substance imitated.

ENCAUSTIC TILES.

For certain portions of paving, where the utmost cleanliness is especially desirable, these tiles may be used to great advantage. They are very durable, and, considering their cost, may be pronounced one of the most economical materials that can be used. The encaustic tile is also highly ornamental, and, when properly applied, becomes a peculiarly pleasing as well as useful object.

CHAPTER IX.

DESIGNS FOR VARIOUS CLASSES OF COTTAGES AND OTHER BUILDINGS.

In the following designs, from the labourer's cottage upwards, the chief study of the designer was the inside arrangements,—to accomplish the utmost possible accommodation and convenience, so as to adapt the various dwellings, &c., to the purposes for which they were designed. The front elevations are also on a simple principle of arrangement, and without profusion of useless ornaments. The estimates given of each design are taken at an average, as building varies much in different parts of the country, both as to cost of materials and labour.

It may also be remarked, that before a building of any extent is erected, the design should be drawn in some manner, to show, as near as possible, what will be the real effect of it when executed. This is done generally by geometrical elevation; by perspective views, as in the frontispiece; and sometimes by models. The geometrical plans and elevations are indispensable, because neither views nor models can be made until the architect has fixed on his plans. At the end of this work are given a ground plan and isometrical view of a farm-steading. This last mode of representing a building gives a very good idea of the extent, and of the effect it would have in viewing it from an eminence.

The specification given at the conclusion of the work applies generally to the designs, as it would be impossible to form one which would apply in every case; a mere outline is given, which may be considered as the ground-work upon which a detailed specification is to be made out.

The necessity of providing suitable and commodious cottages for the rural population is now all but universally acknowledged by the class of proprietors, not a few of whom have distinguished themselves by their benevolent exertions in this—the first step to an improved moral and social condition. Among these proprietors the Duke of Bedford holds a distinguished place. His grace has either finished, or has in course of erection, three hundred cottages, of an admirable construction, on his property at Woburn Abbey and in Devonshire; an example nobly imitated by his grace the Duke of Northumberland, in the north of England; by the Earl of Chichester, on his Sussex estates; and by the Marquis of Breadalbane, Lord Haddington, and other extensive landowners, both in England and Scotland.

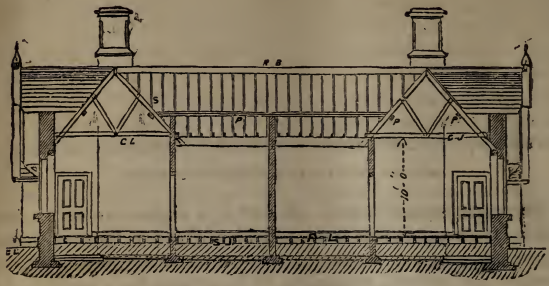
But probably the earliest builder of improved cottages was Howard, the philanthropist. "When he first went to reside at Cardington, in Bedfordshire," writes his biographer, Mr. Hepworth Dixon, "he found it one of the most miserable villages in England. His first step was that of rendering the homes of the poor dwellings fit for self-respecting men,—the starting point of every true social and industrial reformation. Having decided that the miserable huts in which he found the cottagers should be taken down, he carefully selected some good and convenient plots of ground, on which he caused the same number of very superior cottages to be built, and transferred to them such persons as he most approved for his tenants."

PLATE I., FIG. I.—DESIGNS, WITH PLAN AND ELEVATION, FOR A SINGLE ROW OF LABOURERS' COTTAGES.

The accompanying design is for *four* of a single row of one-storey labourer's cottages, with front and back gardens attached to each cottage, and may be considered, so far as the extent of inside accommodation and external appearance, to be suitable for a superior class of labourers. The outside elevation is pleasing and of very simple construction; and a row can be extended to any length, by having the low roofs and gable ends alternately, as shown on plans and elevation. The entrance to each cottage is from the front garden into a small lobby, from which access is obtained into a living room, 16 feet 6 inches by 13 feet; bed-room, 12 feet by 11 feet, and closet. A scullery, 12 feet by 10 feet; and a back bed-room, 12 by 12 feet, enter from living room; also a pantry, 8 by 7 feet 6 inches; a back door leads from scullery into back garden, in which the house conveniences are placed —viz., coal-cellar, privy, and ash-pit, with small courts for pigs. By raising the gables in front about two feet higher another bed-room could be obtained by a small stair leading from living room.

The four cottages, as shown on plan and elevation, will cost about £600, or £150 each cottage.—(See also Plate 2).

PLATE I., FIG. II.—DESIGN FOR A DOUBLE ROW OF LABOURERS' COTTAGES.



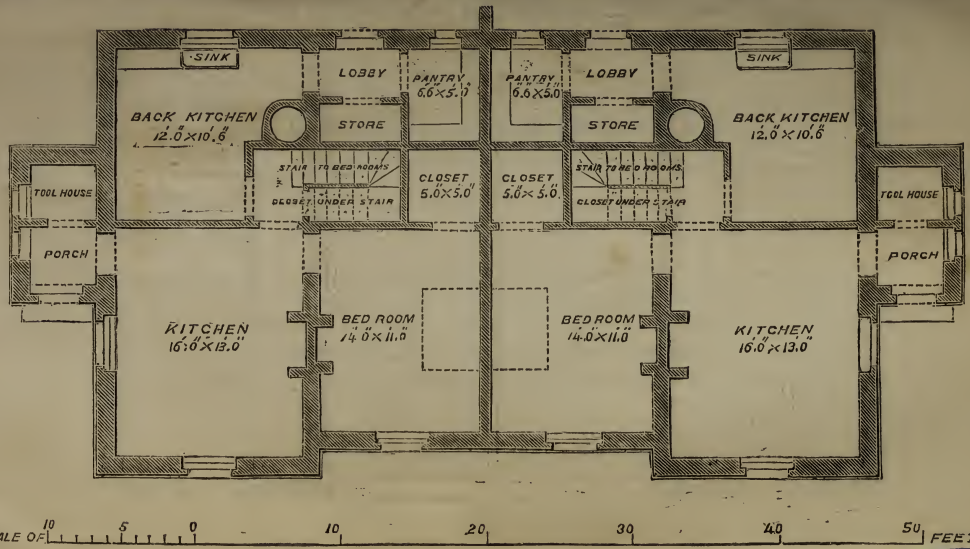
Lateral Section of the Double Row of Labourers' Cottages.

R B, Ridge Board—C L, Ceiling Line—G L, Ground Line—P, Purlins—S, Spars—F L, Floor Line—S J, Sleepers, Joistings, &c.

This design is suggested as being a better arrangement than that usually adopted in the erection of double rows of cottages. In place of building them in continuous rows, we have designed them to be in continued detached blocks, each block containing four cottages, with small courts and outhouses between each block, thus giving sufficient space for conveniences and free ventilation, giving also a uniform and neat outside appearance to each front elevation or row. The diagonal line of the blocks (if the ground permits) should be north and south, so that each side will receive the sun's rays some part of the day. From the scullery of each cottage a small open area is obtained, in which any slop-work may be done, thus keeping the scullery and living room clean, dry, and comfortable. Each cottage contains an entrance lobby, with small closet; a living room, 15 feet by 12 feet 6 inches; scullery or back kitchen, 8 feet 6 inches by 8 feet, with boiler; open area from ditto, 8 feet by 7 feet; also two bed-rooms—front one, 12 feet by 12 feet, and back one, 12 feet by 10 feet. A small front garden is attached to each cottage, from which the doors to court enter; each court contains coal-cellar, ash-pit, and privy.

This design of each block of four cottages, with courts and outhouses, will cost about £500.—(See also Plate 3).

PLATE IV.—PAIR OF LABOURERS'



PAIR OF LABOURERS' COTTAGES.—GROUND PLAN.

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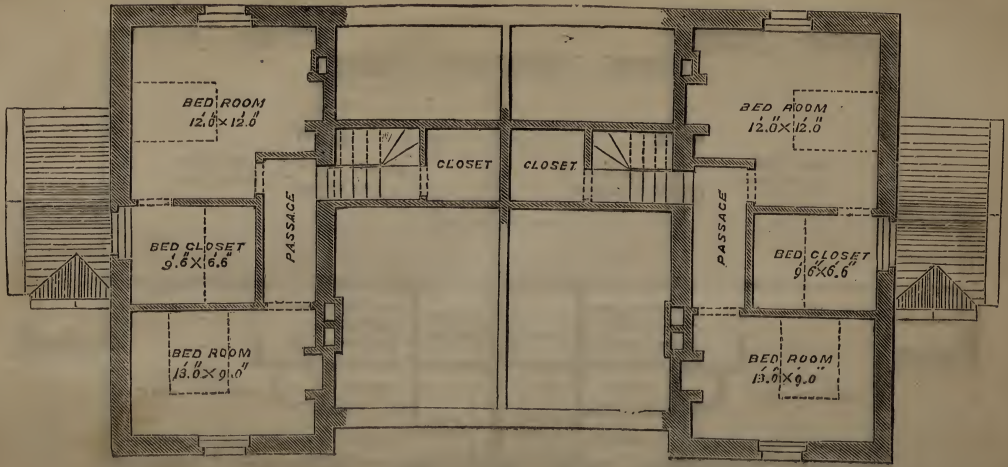

PAIR OF LABOURERS' COTTAGES.—CHAMBER PLAN.

PLATE I, FIG. I.—ELEVATION OF SINGLE ROW OF LABOURERS' COTTAGES.

PLATE I, FIG. II.—ELEVATION OF DOUBLE ROW OF LABOURERS' COTTAGES.

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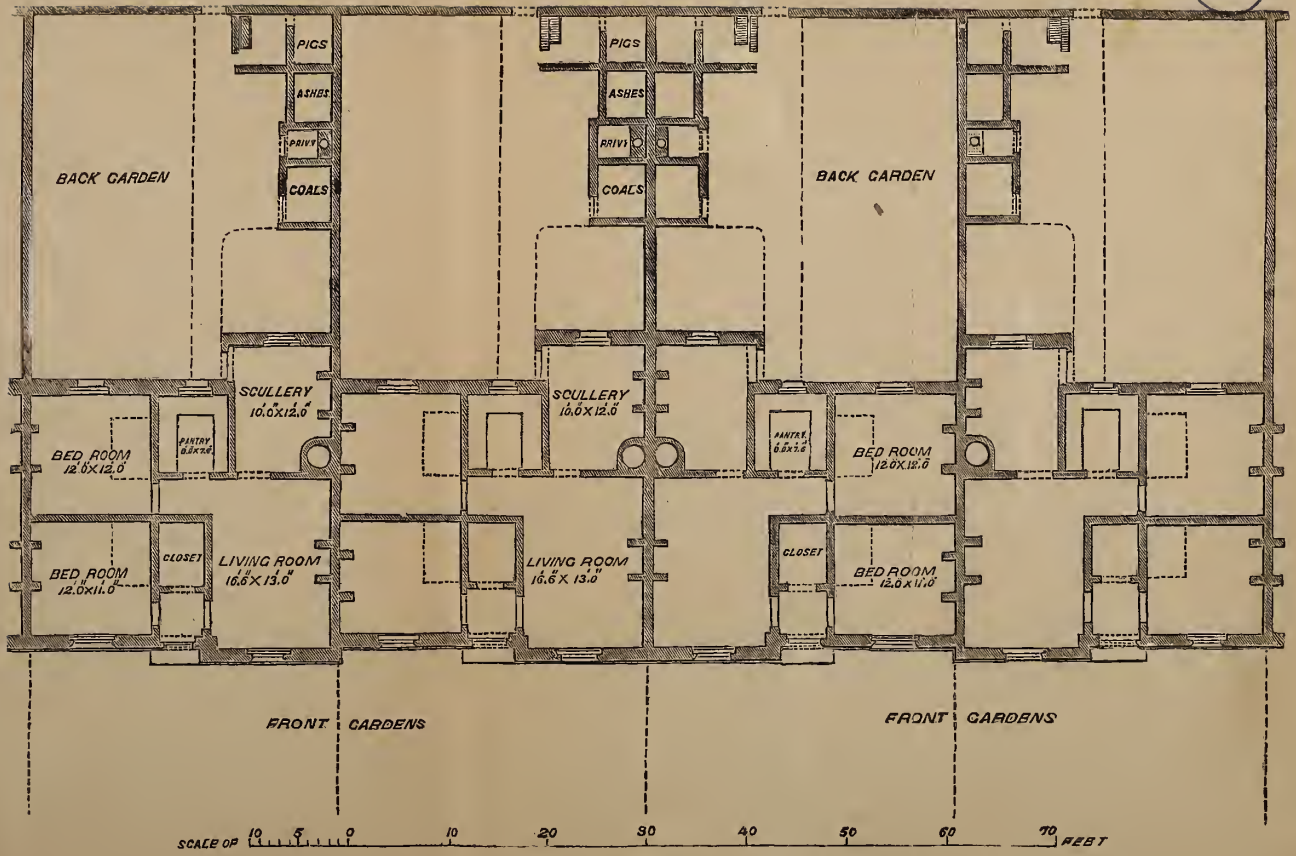

PLATE II.—SINGLE ROW OF LABOURERS' COTTAGES.—GROUND PLAN.

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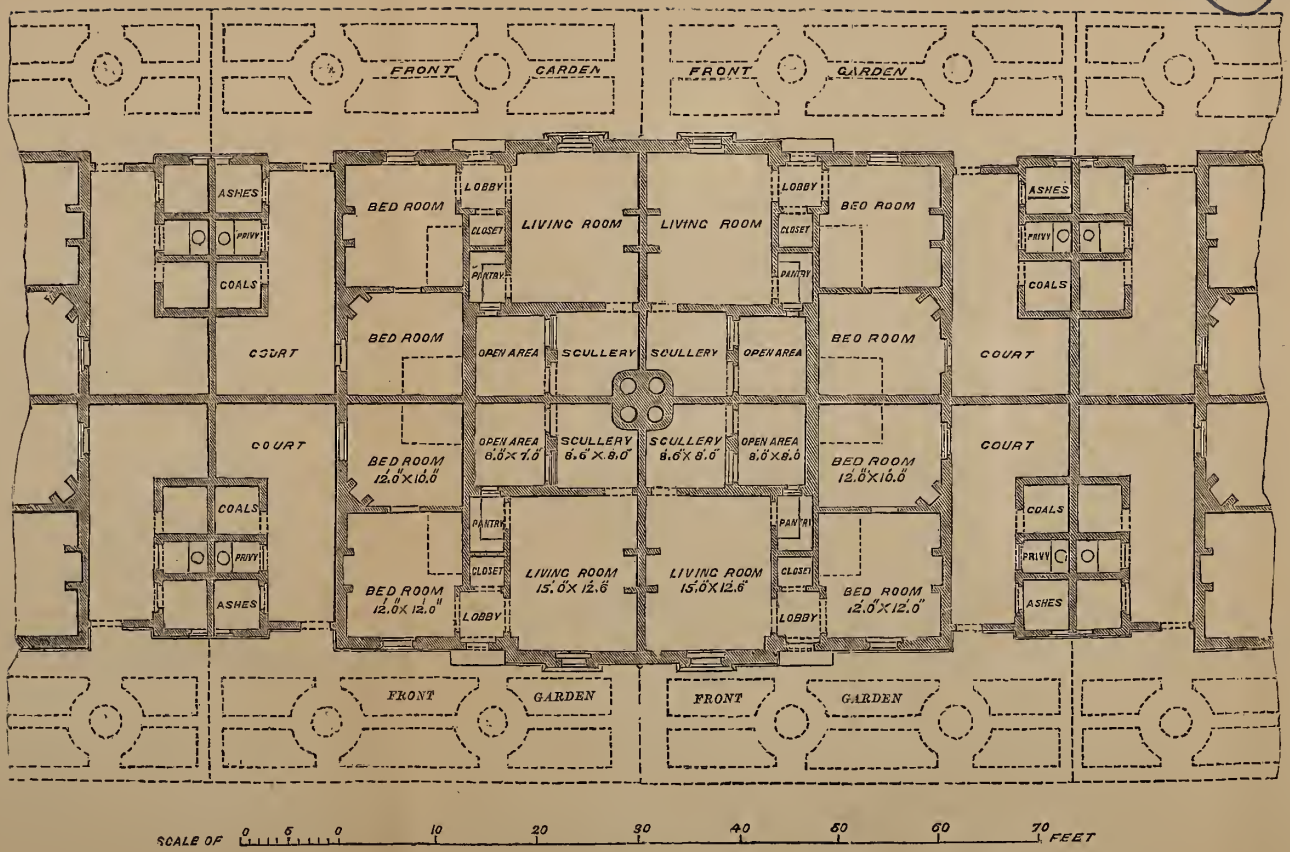

PLATE III.—DOUBLE ROW OF LABOURERS' COTTAGES.—GROUND PLAN.

Longitudinal Section of a Pair of Labourers' Cottages.

DESIGN FOR A PAIR OF LABOURERS' COTTAGES, WITH SUITABLE ACCOMMODATION FOR A SMALL FAMILY.

This design is submitted as being convenient, plain, and cheap; and to acquire the requisite accommodation, it has been preferred to carry up the wings two storeys in height, rather than to extend the ground plan, thus having the bed-rooms in a more airy situation: the stair is placed so as to have easy access to the bed-rooms above, without inconvenience to the apartments below. The front elevation may either be executed with stone dressings, or in plain brickwork, having only stone sills; the cantilavers of roofs may also be dispensed with, all without altering the general appearance of the design.

It will be seen on examination of the drawings, that each cottage contains on the ground-floor an entrance porch, placed at the end, with tool-house attached; kitchen, 16 feet by 13 feet; back kitchen, 12 feet by 10 feet 6 inches, with boiler and sink; bed-room, 14 feet by 11 feet, with small closet entering therefrom. This floor also contains small lobby to back garden, with pantry and store-closet, and small closet below stair. This stair, leading to chamber-floor, has a small store or closet entering from first landing above closet, off bed-rooms below. The coal-cellar, ash-pit, &c., may be placed at a convenient distance in back garden.

The chamber-floor of each cottage contains two good bed-rooms and bed-closet; one bed-room, 12 feet by 12 feet, and the other 13 feet by 9 feet; the bed-closet 9 feet 6 inches, by 6 feet 6 inches, the two bed-rooms entering seperately from passage. This passage and stair may either be lighted from roof or by borrowed lights over bed-room doors.

The cost of erecting a pair of these cottages will be about £330.—(See Plates 4, 5, and 6).

Side Elevation.

DESIGNS, WITH PLANS AND ELEVATIONS, OF A DOUBLE COTTAGE.

Plates 7, 8, and 9.

The objects in view in preparing this design, of which the frontispiece is a perspective view, were to keep the entrance doors as far separate as possible, the rooms to enter separately from a lobby, doing away with the inconvenience of passing through one apartment into another, the staircase starting from the same lobby, from the landing of which a distinct entrance is got to each bed-room, so that the utility and comfort of the rooms are increased.

The ground plan of each cottage contains an entrance porch and small lobby and staircase, with living room, 14 feet by 12 feet; kitchen, 12 feet 6 inches by 10 feet 6 inches; pantry, 10 feet by 6 feet 3 inches; store, 6 feet 3 inches by 6 feet; and small tool-house below

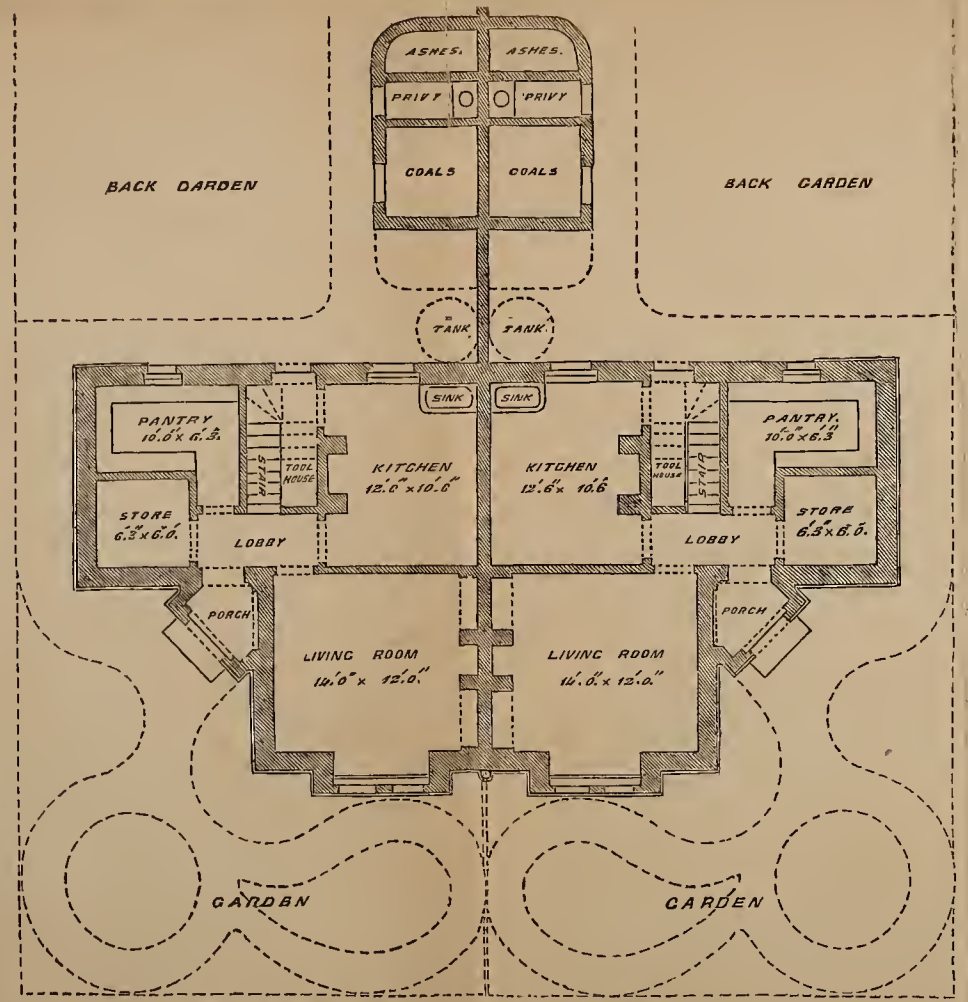

PLATE VIII.—DOUBLE COTTAGE.—GROUND PLAN.

X

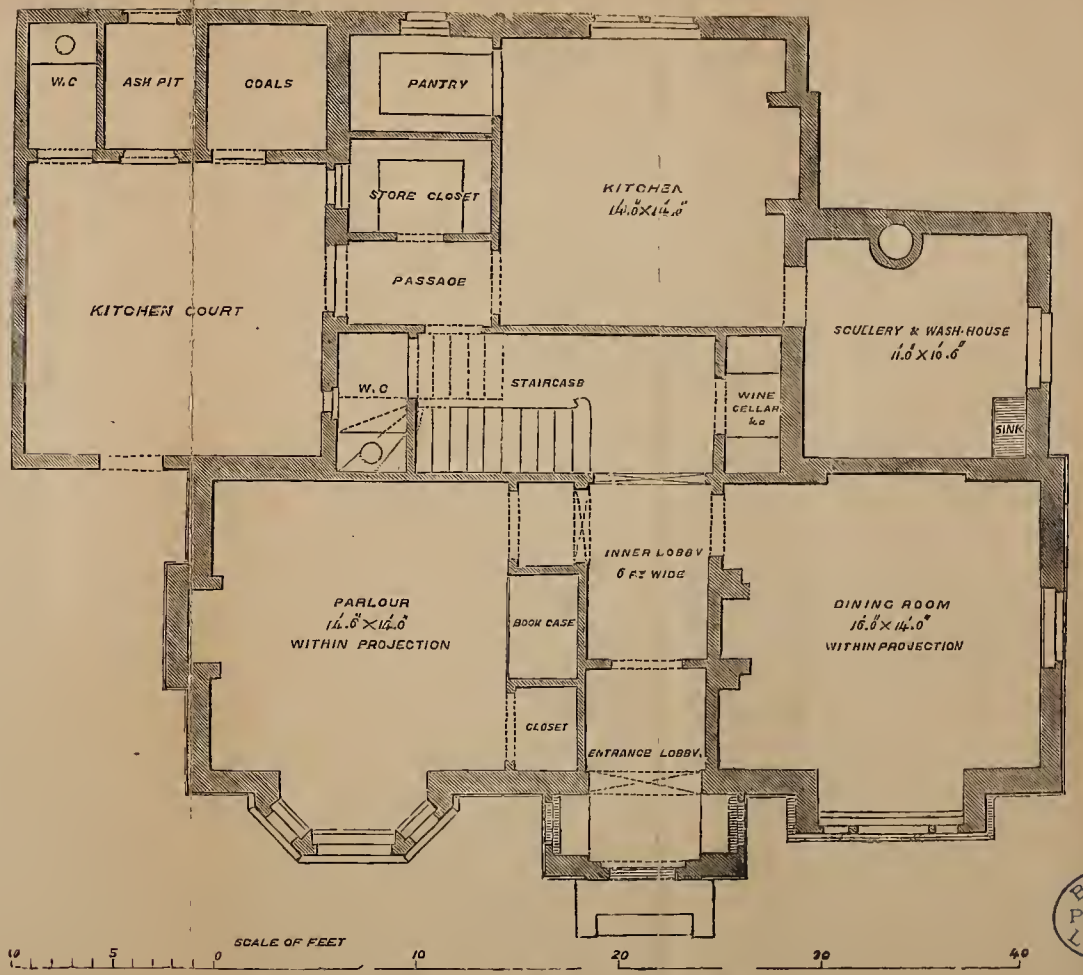

PLATE XI.—VILLA, NO. I.—PLAN OF GROUND FLOOR

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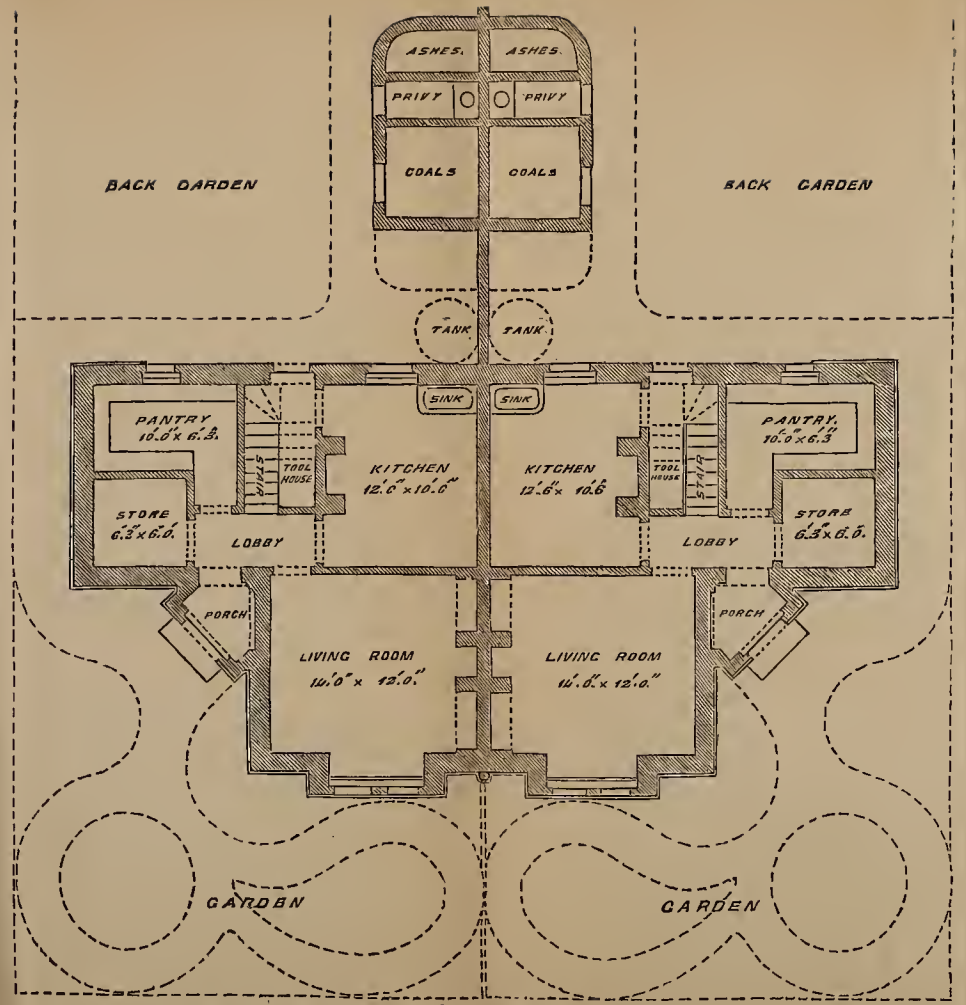

PLATE VIII.—DOUBLE COTTAGE.—GROUND PLAN.

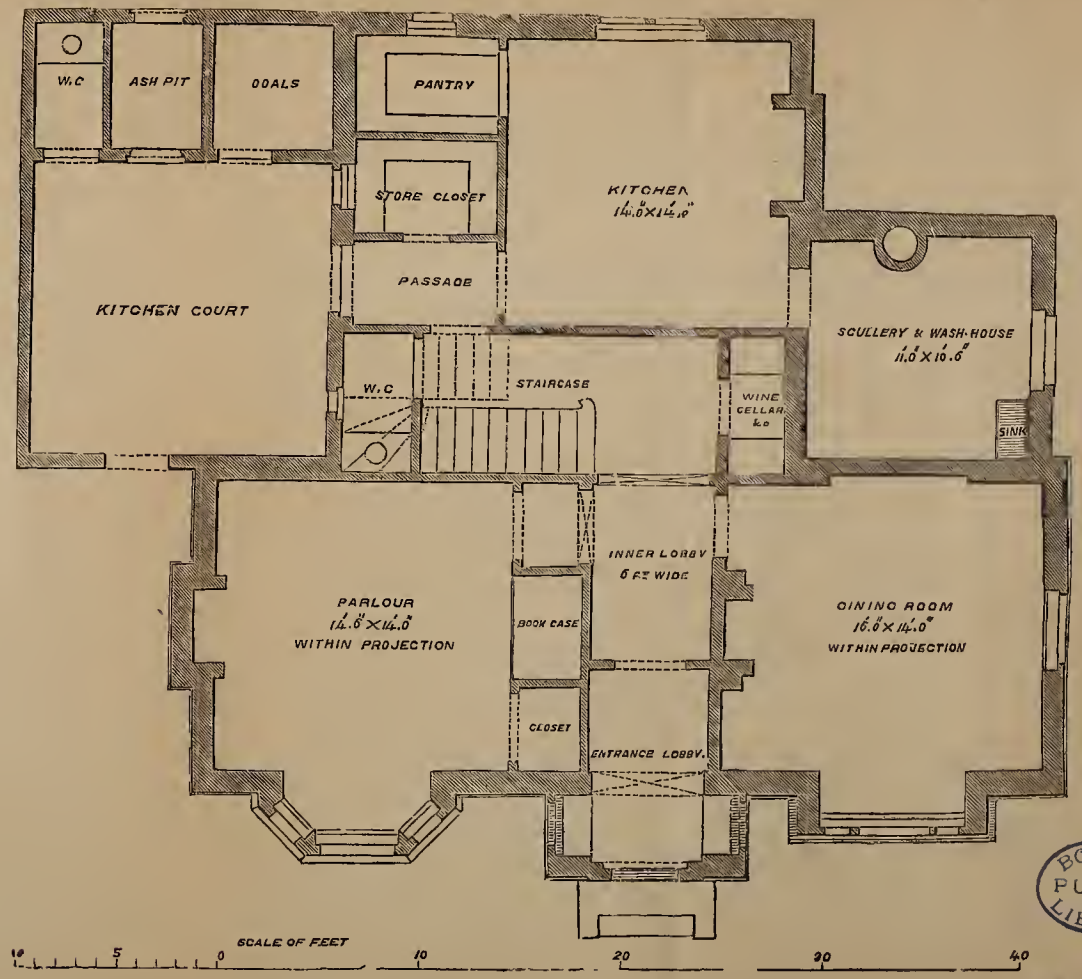

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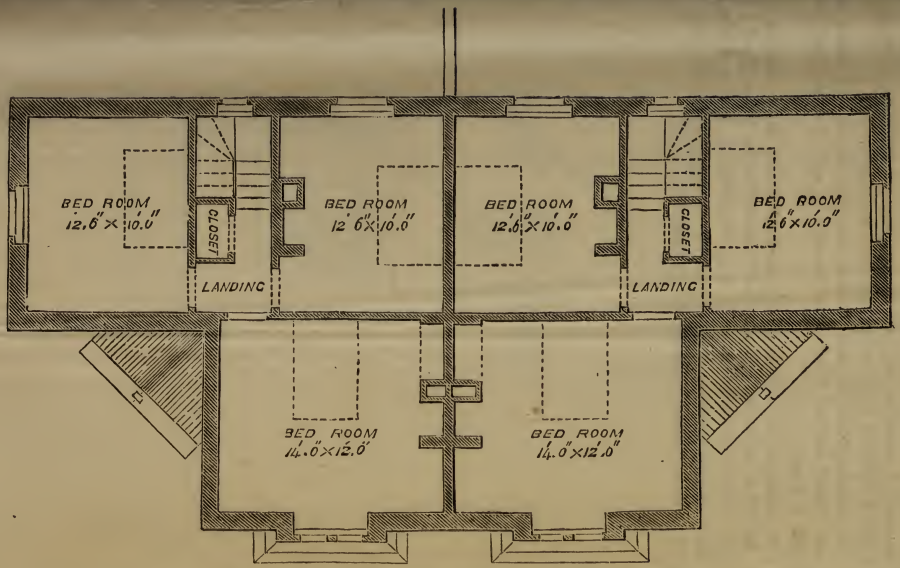
PLATE XI.—VILLA, NO. 1.—PLAN OF GROUND FLOOR

Plate 9.



PLAN OF DOUBLE COTTAGE.—CHAMBER FLOOR.

stairs, with a back door out into back garden, in which are placed at a suitable distance a coal-cellar, ash-pit, and privy.

The chamber-floor of each cottage contains three bed-rooms, of suitable sizes, two of which have fire-places, and a small closet at landing of stair.

The height of the ceiling of ground-floor will be 9 feet clear, and the height of bed-room ceilings will be 9½ feet to the ceiling joists.

The cost of construction will vary according to the locality which it may be erected; but taken at an average, the cost for building the double cottage would be about £370.

PLATE VII.—DOUBLE COTTAGE.—FRONT ELEVATION

PLATE X.—DESIGN FOR A VILLA NO. I.—FRONT ELEVATION.

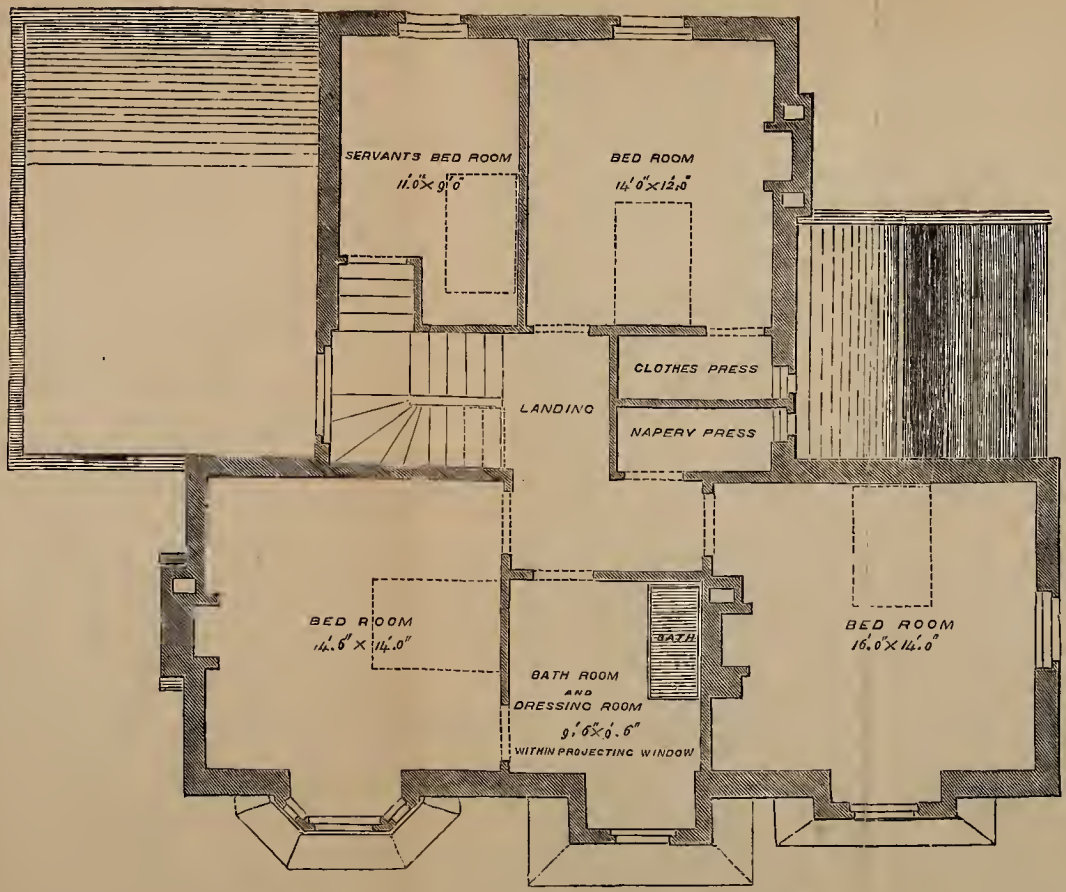


PLATE XII.—VILLA NO. I.—PLAN OF CHAMBER FLOOR.

DESIGN, WITH PLANS AND ELEVATIONS, FOR A SMALL VILLA.

Plates 10, 11, and 12.

No. I.

The accompanying design for a small villa would, as regards its accommodation, be suitable as a country residence for a gentleman with a moderate income, a yeoman, or small landed proprietor. The style is very picturesque; and if erected upon the top of a sloping bank, would form a very pleasing object to the eye. The walls to be built of brick, and the corners and dressings of doors and windows to be of stone. The cornice and cantilavers of projecting roofs to be of wood, painted, and sanded over to imitate stone. The principal floor contains entrance lobby, 6 feet wide; dining-room, 16 feet by 14 feet; parlour, 14 feet 6 inches by 14 feet, with a recess for a bookcase or chiffonier, a small wine or beer cellar; kitchen 14 feet square, entering into a scullery or wash-house, 11 feet by 10 feet 6 inches, with a boiler and sink: this floor also contains water-closet, store-closet, pantry, coal-cellar, ash-pit, &c., with small kitchen court.

The chamber floor contains three good bed-rooms, one 16 feet by 14 feet; another 14 feet 6 inches by 14 feet, with bath-room and dressing room, 9½ feet square; and the other one at back, 14 feet by 12 feet, containing a closet for clothes, &c.; also a servant's bed-room, 11 feet by 9 feet, entering from staircase; a napery press is also provided, entering from the floor landing.

The cost of erecting this villa will be on an average about £530.

DESIGNS, WITH PLANS AND ELEVATIONS, OF A VILLA.

Plates 13, 14, 15, and 16.

This design for a villa may be either suitable for a bailiff, yeoman, or landed proprietor. The exterior walls are intended to be of rubble stones, having stone dressings; but if built in a locality where stone is difficult to be got, they may be built with brick, having Roman cement dressings, without altering the appearance or utility of the design. The apartments are laid out so as to embrace every convenience, comfort, and accommodation for a family, the rooms all entering separately from lobbies. The ground or principal floor enters by a porch, 5 feet 6 inches by 5 feet, into a lobby 4½ feet wide, from which access is had into parlour 14 feet by 14 feet, with octagon window; dining room, 16 feet by 14 feet; breakfast-room, 12 feet by 10 feet; the kitchen, 14 feet by 10 feet, enters by a small passage from lobby, with scullery, 8 feet 6 inches by 8 feet, containing boiler and sink. From kitchen a back passage leads into larder, pantry, and store and plate closet. A back door also leads into kitchen garden, in which are placed coal-cellar, poultry-house, privy, and ash-pit. A separate entrance is shown in garden wall leading into kitchen, without coming through the main house. The stair to chamber-floor is placed at end of entrance lobby, from the first landing of which a servant's room, 12 feet by 10 feet, is obtained. The chamber-floor contains three bed-rooms, each 14 feet by 14 feet, and one dressing-room, 6 feet 6 inches by 6 feet; also a closet for napery, and a water-closet.

The cost of erecting this design, according to the plans and elevations, will be about £560.

PLATE XIII.—VILLA NO. II.—FRONT ELEVATION.

PLATE XIV.—VILLA NO. II.—SIDE ELEVATION.

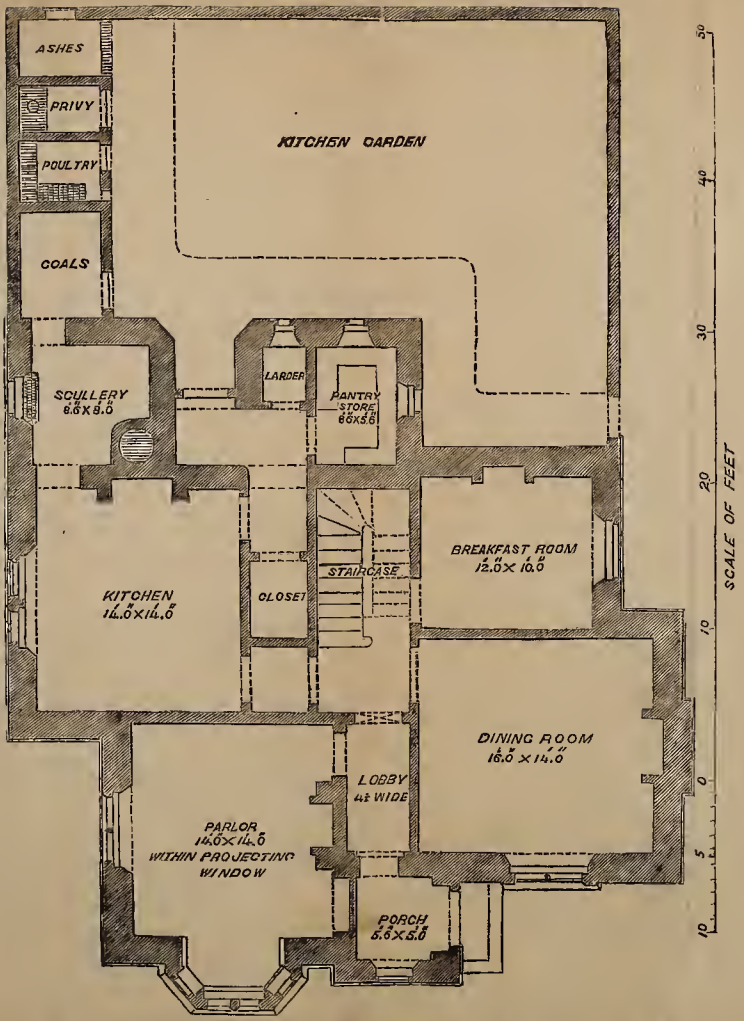
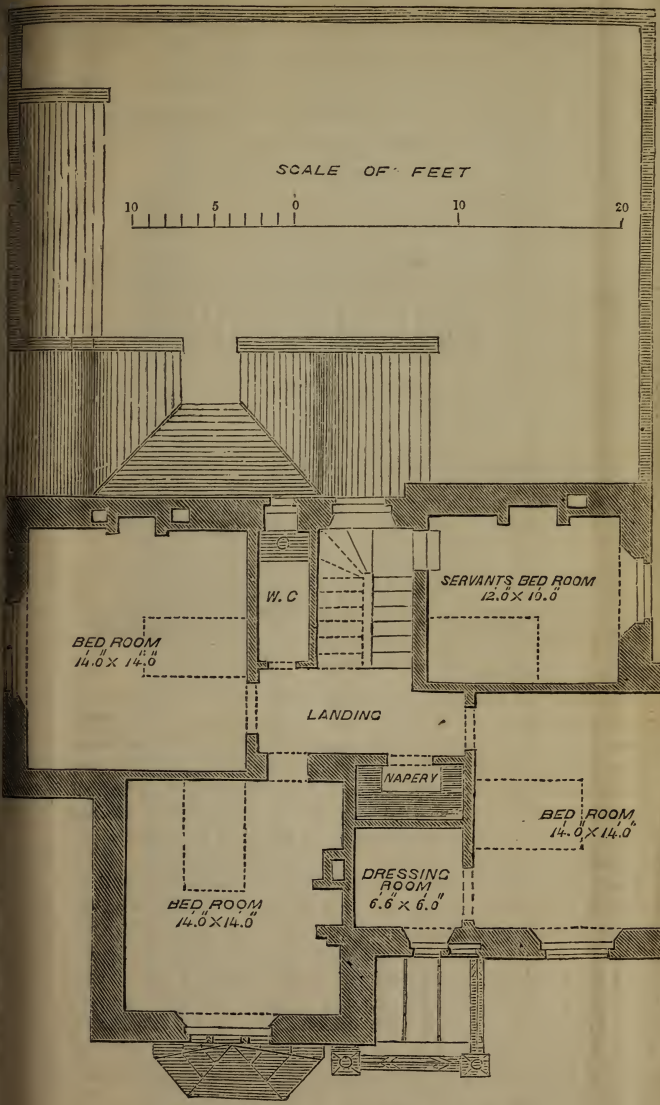


PLATE XV.—VILLA NO. II.—GROUND OR PRINCIPAL FLOOR.



VILLA, NO. II.—CHAMBER FLOOR.

DESIGN, WITH PLANS AND ELEVATIONS, FOR A FARM-HOUSE DETACHED FROM THE FARM OFFICES.

Plates 17, 18, and 19.

Lateral Section.

This design is submitted as having every necessary convenience and accommodation for a better class of farm-houses. The front entrance is from an open porch to a lighted passage or lobby communicating with the parlour, dining-room, and staircase; from the latter an entrance is had to the kitchen and offices, keeping the principal rooms strictly private. The dairy is placed at the end of kitchen passage, thus having every advantage of situation for coolness and free ventilation.

The height of ceiling of ground floor is 10 feet, and that of chamber-floor 9 feet 6 inches. A beer-cellar can be conveniently got below the area of staircase, by excavating about 4½ feet below the level of floor, having a few steps down. The ground-floor contains parlour, 14 feet by 13 feet; dining-room, 16 feet by 14 feet; kitchen, 16 feet 6 inches by 14 feet; scullery, 11 feet 6 inches by 10 feet; staircase; servant's room, 11 feet 6 inches by 7 feet 6 inches; dairy, 11 feet 9 inches by 8 feet 9 inches; pantry, 6 feet by 5 feet; store, 6 feet by 5 feet; and

PL[illegible]RM HOUSE.—FRONT ELEVATION

PLATE XIX.—FARM HOUSE.—PLAN OF GROUND FLOOR.

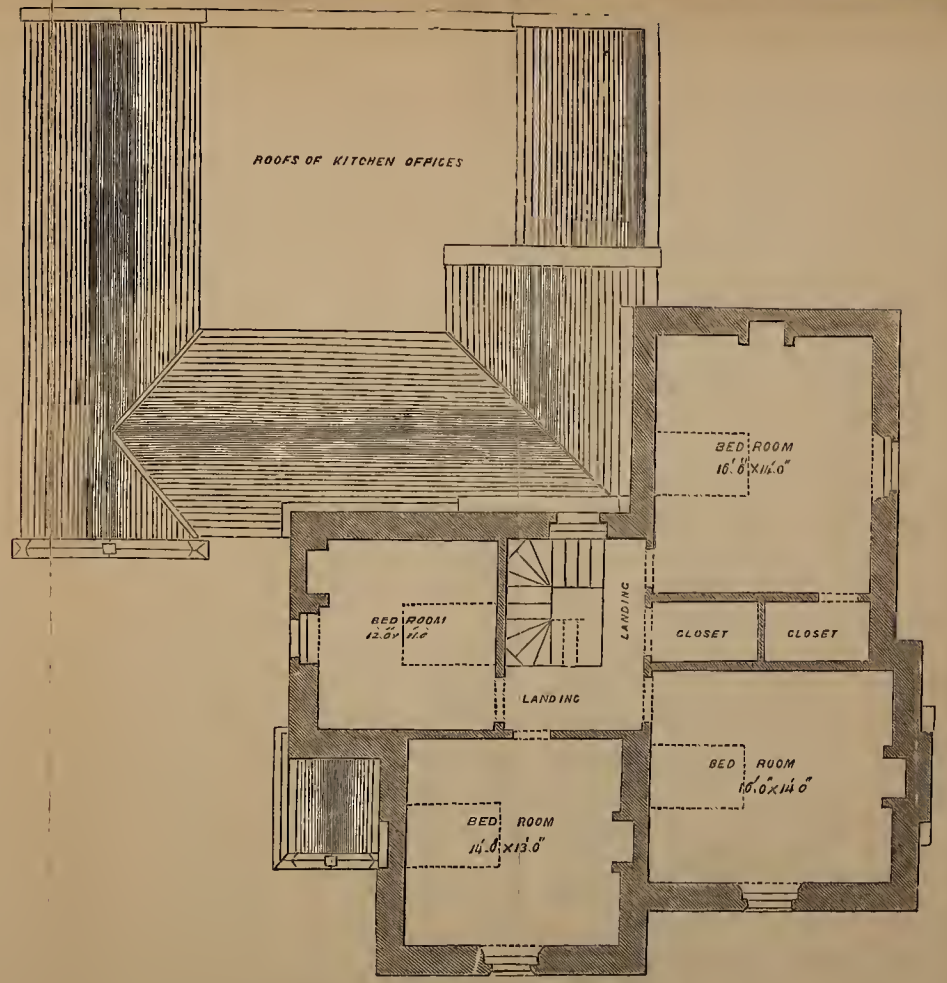
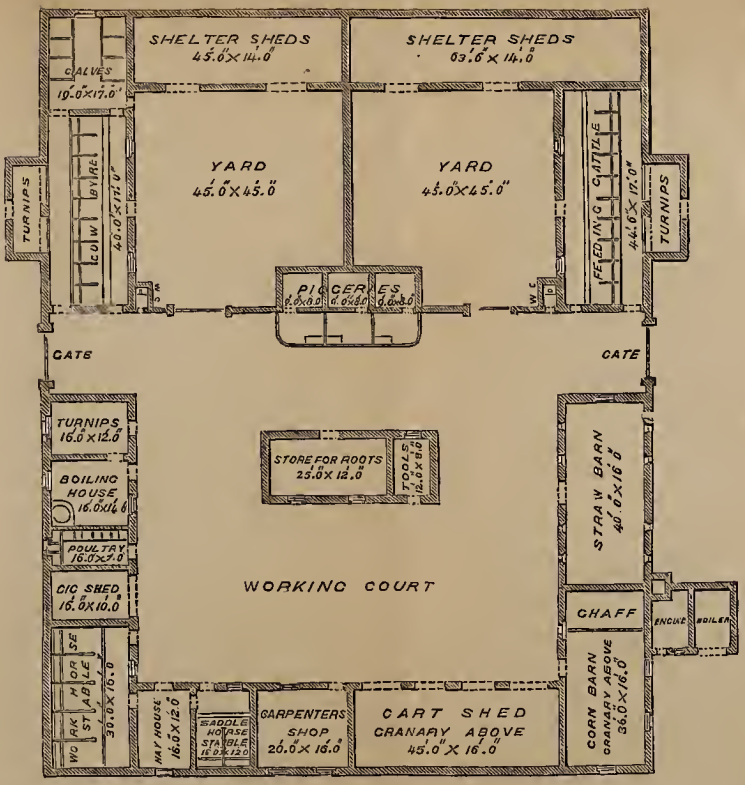


PLATE XVIII.—FARM HOUSE.—CHAMBER FLOOR.

PLATE XX.—ISOMETRICAL VIEW OF FARM STEADING.



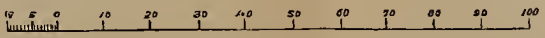
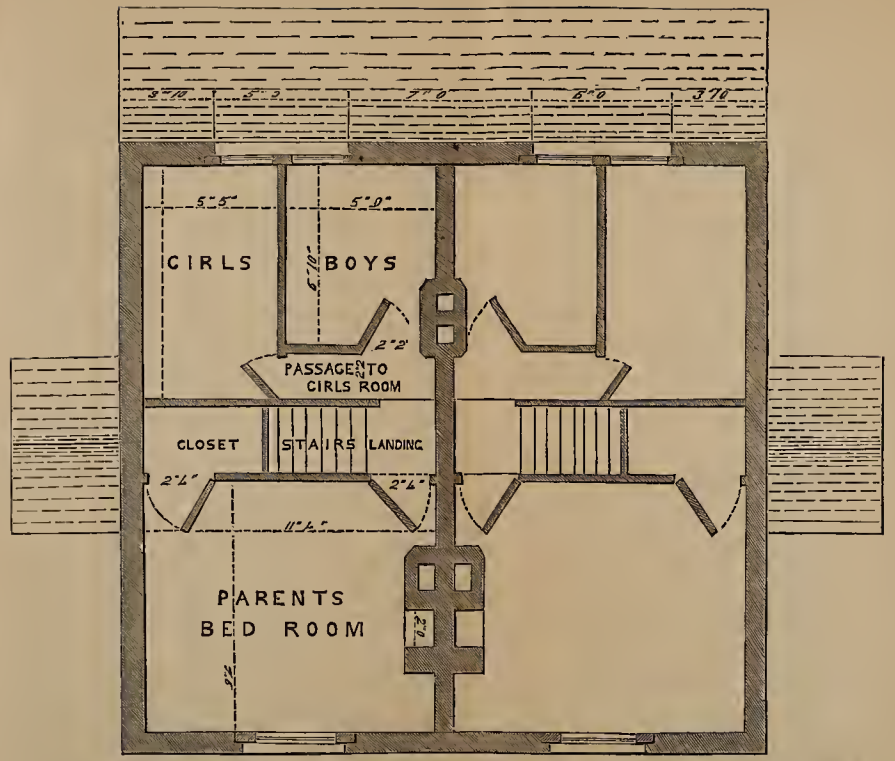
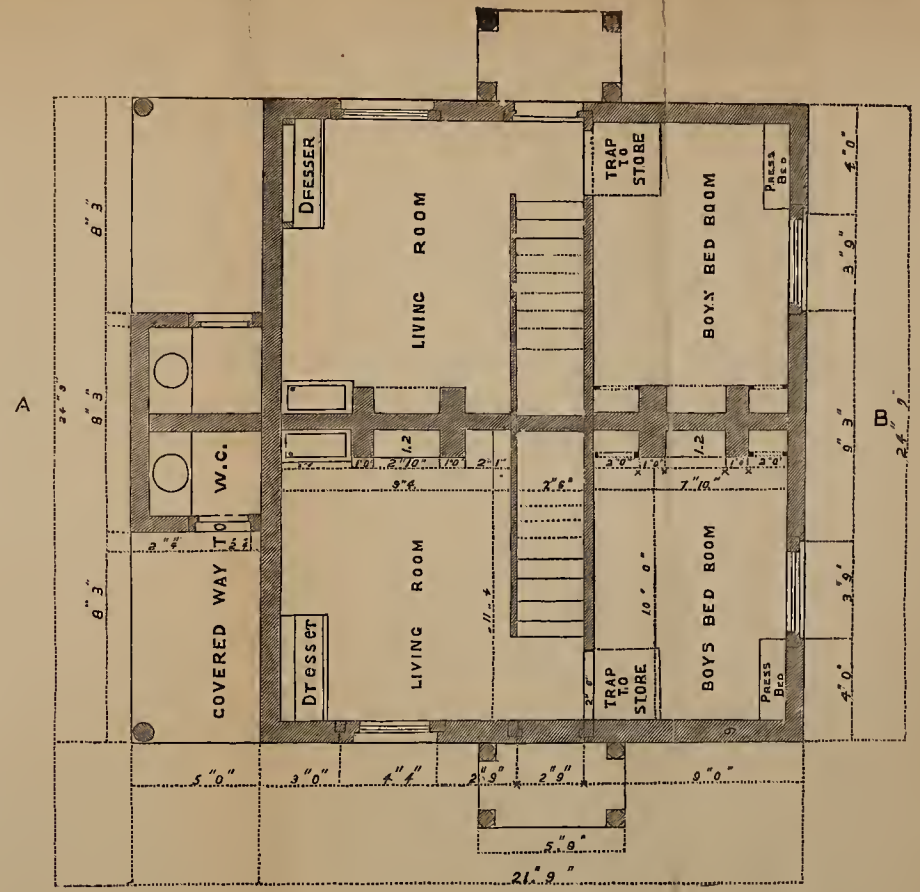


PLATE XXI.—FARM STEADING.—GROUND PLAN.



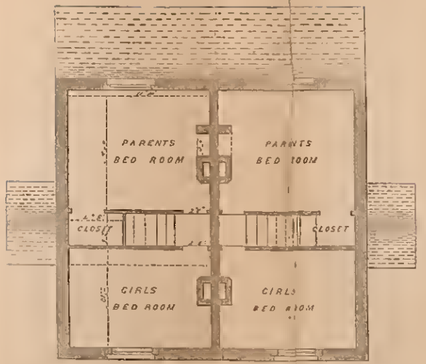
PLAN OF UPPER FLOOR

PLATE XXX.



PLAN ON GROUND FLOOR

PLATE XXII.



PLAN OF UPPER FLOOR

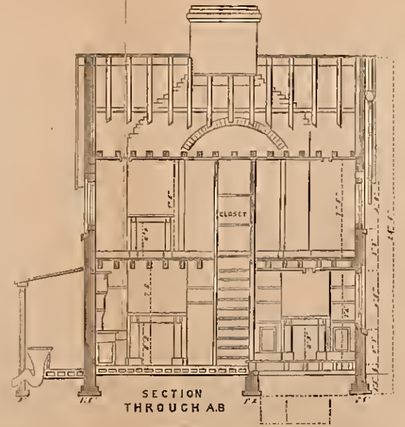
PLATE XXX

SIDE ELEVATION

PLATE XXVI.

BACK ELEVATION

PLATE XXV.

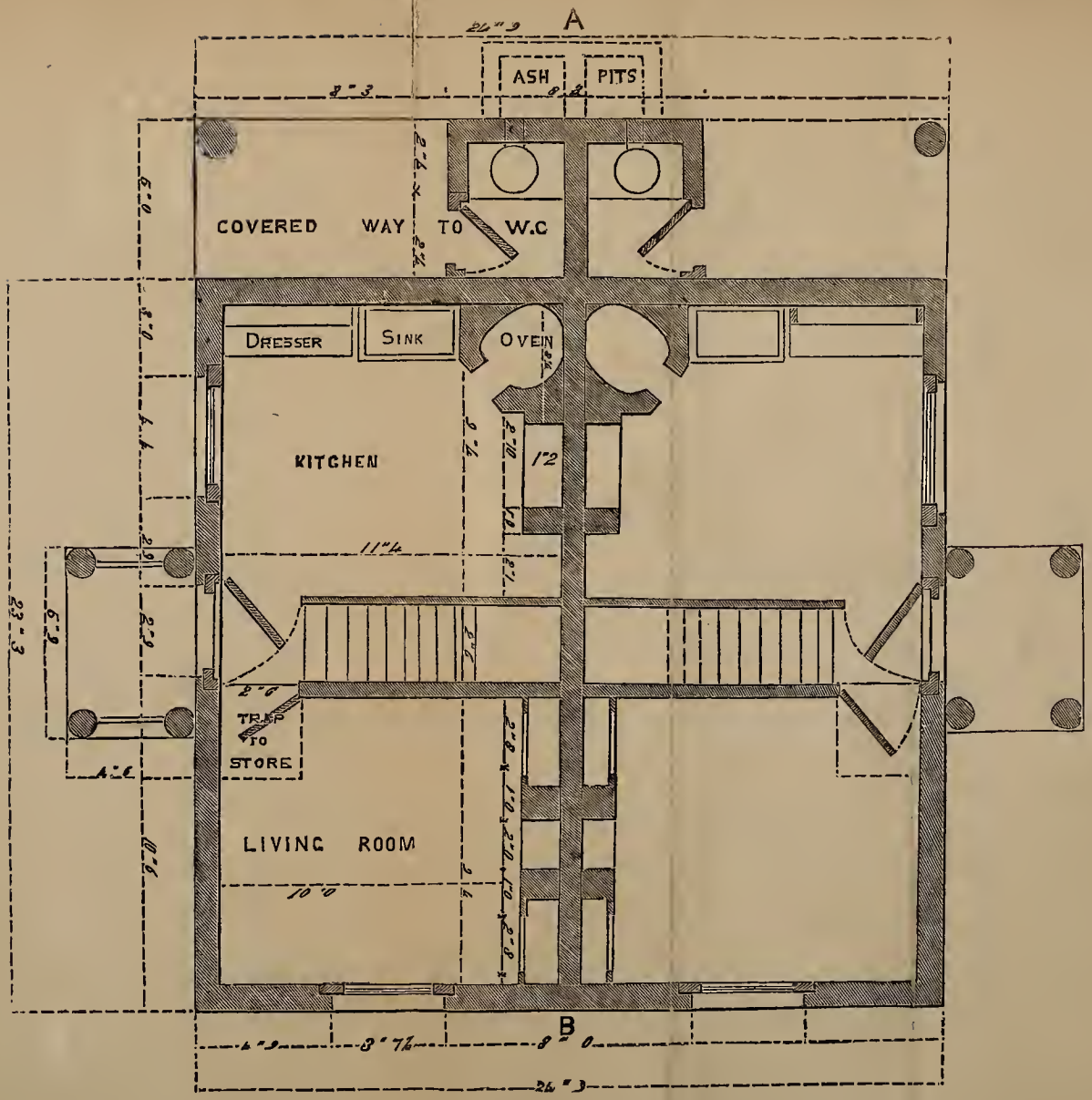


SECTION THROUGH A.B

PLATE XXVII.

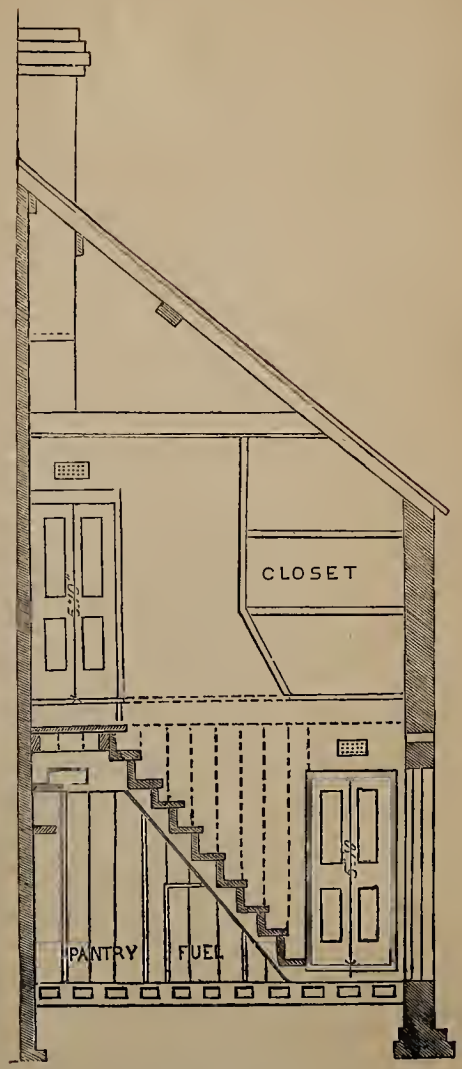
FRONT ELEVATION

PLATE XXIV.

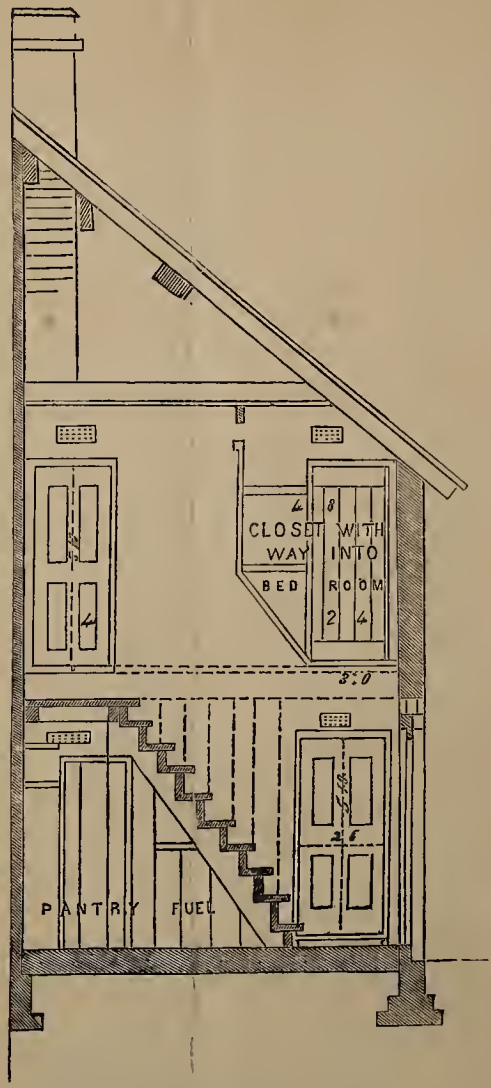


PLAN ON GROUND FLOOR

PLATE XXIX.



CROSS SECTION
PLATE XXVIII.



CROSS SECTION
PLATE XXXI.

two closets, one from kitchen, and the other from dining-room. From kitchen court are coal-cellar, root-cellar, and tool house, with ash-pit and privies.

The chamber-floor contains four bed-rooms, two of which are each 16 feet by 11 feet, one 14 feet by 13 feet, and the others 12 feet by 11 feet 6 inches, with two closets for napery, &c.

The cost of this design will be about £600.

DESIGN FOR A FARM STEADING, SHOWN BY A PLAN AND ISOMETRICAL VIEW.

Plates 20 and 21.

This steading encloses 160 feet by 132 feet, and contains straw barn, 40 feet by 16 feet; corn barn, 36 feet by 16 feet; cart shed, 45 feet by 16 feet; carpenter's shop, 20 feet by 10 feet; two-stall hackney stable, 16 feet by 12 feet; hay house, 16 feet by 12 feet; five-stall cart house stable 30 feet by 16 feet; gig house, 16 feet by 10 feet; poultry house; boiling house 16 feet by 14 feet 6 inches; turnip house, 16 feet by 12 feet; byre for 9 cows, 40 feet by 17 feet; calf house 19½ feet by 17 feet; ten stalls for feeding cattle, 44 feet 6 inches by 17 feet; two shelter sheds; piggeries, tool house, root house, granaries on upper floor; engine and boiler house &c., &c.

CHAPTER X.

THE HEADS OF A SPECIFICATION OF THE DIFFERENT WORKS REQUIRED AND GENERALLY APPLICABLE IN THE ERECTION OF THE FOREGOING DESIGNS.

DIGGING.

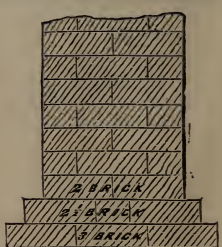
THE site of the building to be excavated to the proper levels that may be found necessary for the foundations, drains, cesspools, and other works. To ram down to a hard consistence the tracts for the footings of the intended walls, and to fill in and level about the foundations the soil so dug out after the same have been constructed. To execute on the whole site upon which the building is erected such other groundwork as may be required to level and render the work complete, and to clear away all rubbish that may accumulate from time to time during the progress of the work.

DRAINS.

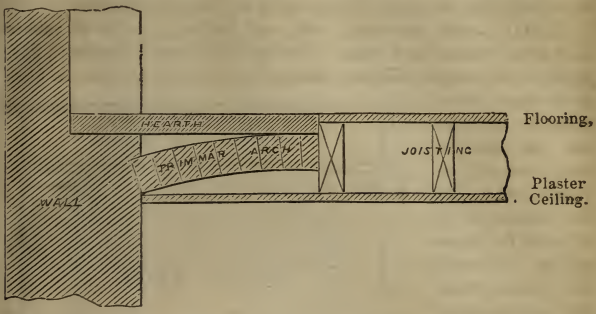
All the drains to be constructed of glazed earthenware pipes, having spigot and faucet joints, carefully jointed together with cement, having a proper declivity, and trapped where necessary.

BRICKWORK.

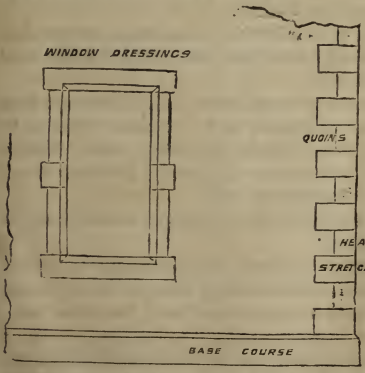
All walls to have from *two to three courses of footings;* and where the ground is of a soft nature, these footings to be laid solid on a bed of concrete, from 10 to 12 inches thick; to prevent any damp rising, the walls at the level of the ground to be covered over with a composition of Norway pitch and tar, well boiled, and laid on with a brush. To execute in the very best and workmanlike manner all brickwork necessary for the building; and no four courses of bricks to rise more than one inch besides the height of bricks. The bricks used to be of the best quality, well



shaped, and thoroughly burnt, and those for the exterior face of walls to be of a uniform colour. All hearths to have brick trim-



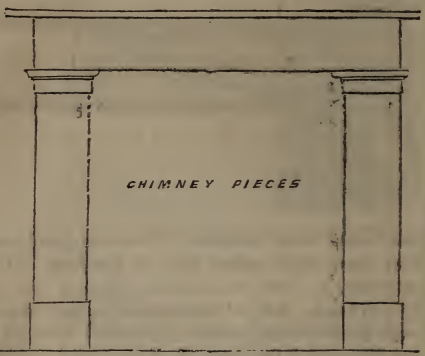
mer arches where necessary. Carefully build and parget all chimney flues; turn brick arches over all openings. The fire-places, where necessary, to have wrought-iron chimney bar, $2\frac{1}{2}$ inches broad by $1\frac{1}{2}$ inch thick. Cut all chasings and rabbets required, make good, and leave all the work perfect. Construct cesspool, where required, $3\frac{1}{2}$ feet diameter, 6 feet deep, of $4\frac{1}{2}$ inch brick, set in cement. To build, for the support of sleepers of the ground-floor, brick piers, 9 inches square and 9 inches high, and not more than 4 feet apart, having one course of footings, $13\frac{1}{2}$ inches square.



To lay the floors of kitchens and passages with blue and red Staffordshire tile, bedded in mortar, and the sculleries and pantries with common hard bricks, bedded and jointed in mortar, and the ground underneath to be formed to the thickness of 6 inches, with smithy ashes or other dry materials. Build air gratings in walls below timber floors and in pantries, for

ventilation. Set all grates with fire bricks and fire-clay mortar. All the mortar used in the brick-work to be made of good, fresh, and well-burnt lime, sharp pit or river sand, and clear fresh water.

MASON :—All door-steps, sills, and landings, to be of rubbed Yorkshire or other hard stone. The *quoins*, window dressings, door jambs, base courses, cornices, chimney caps, and fact tables, to be of good clean stone, tooled on the face, and all laid on their natural or quarry bed. The fact tables to be rabbeted for slates and set in cement. The jambs, mantels, and shelves of chimney-pieces, to be of clean rubbed York or Portland stone. The kitchen fire-places to have rubbed solid jambs and lintels built into the wall. Put to each fire-place a rubbed stone hearth, 1 foot longer than the opening of fire-place, and not less than 20 inches broad, with proper back hearths.



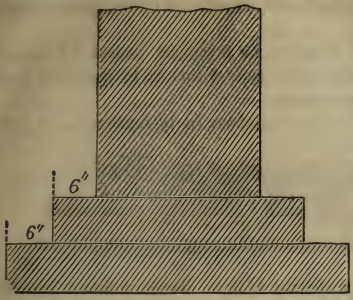
The kitchen and passages to be laid with rubbed flags, not less than 2 inches thick, square jointed, 1-inch back, and laid solid on a good bed of mortar (or, see Brickwork).

The sculleries and pantries to be laid with tooled Yorkshire flags (or, see Brickwork) on a bed of mortar, and the ground under to be formed with small stones, broken bricks, or smithy-ashes. Provide all these paved floors with stone or cement skirting, $4\frac{1}{2}$ inches broad, projecting $\frac{3}{4}$ inch from face of plaster or wall.

Fit up, in all sculleries, stone sinks fixed on proper bearers, and cut out to receive waste and grating.

Where walls are executed with stone, the foundations to be laid with two courses of large flat-bedded stones, 6 inches thick, having two equal six-inch scarcements on each side of wall, laid cross band. The walls above foundation courses to be built to the form shown on drawings, of good rubble stones, neatly and square dressed, well packed and hearted, and bound with headers to go two-thirds through the

thickness of wall every foot in height, and from 3 to 5 feet apart.



Level all walls at the height of every 20 inches, for receiving bond timbers where the walls require battening and strapping. All chimney flues to be 11 inches square, carefully and easily turned and pargeted with good mortar. The quoins and jambs of doors and windows to be built *header* and *stretcher* alternately. The steps of stairs to be of rubbed stone, worked with nozing and fillet, the soffit to be also rubbed. To perform all jobbings that may be required, such as cutting chasings for lead and slates, holes for pipes, &c., and iron balusters for stairs.

CARPENTER AND JOINER :—Provide all voids with safe lintels, 1 inch thick for every foot of opening, having 9 inches of wall-holed at each end.

Where walls are battened and lathed, provide bond timbers, 3 inches by $1\frac{1}{4}$ inch thick, at the height of every 20 inches.

All apartments on ground-floor not flagged to have sleeper joists, 7 inches by $2\frac{1}{2}$ inches. The joistings for chamber floor to be 9 inches by $2\frac{1}{2}$ inches, and properly trimmed for hearths and stair landings; trimmers to be 4 inches thick. The joisting in each room to be properly strutted with one bay of cross struts the full depth of joists. All joisting to be laid on wall plates, $4\frac{1}{2}$ inches by $2\frac{1}{2}$ inches.

The roofs to be formed as shown on drawings. They will have two rows of purlins, 8 inches by 3 inches, fixed vertically, having straining pieces, 6 inches by 3 inches, framed into them, and secured by iron-strap bolts. The spars to be 3 inches by $2\frac{1}{2}$ inches; wall plate, $4\frac{1}{2}$ inches by 3 inches; ridge piece, 6 inches by $1\frac{1}{2}$ inch, having ridge batten 2 inches diameter, firmly fixed; ceiling joists 3 inches by 2 inches; battens for slates, 2 inches by $\frac{3}{4}$ inch, laid to gauge for slates.* All joisting and roofing not to exceed 11 inches apart. Gutter

* In some localities it is the practice to cover the spars of roof with three-fourth-inch boarding, rabbeted, and closely jointed, and well nailed to the spars. This is much better than battens where small slates are used.

boarding to be 1 inch thick, with bearers 3 inches by 2 inches; eaves boards 4 inches by 2 inches, feathered, edged, and tilting pieces where required.

Quarter partitions to be 4 inches by 2 inches, placed 12 inches apart, having head pieces and sills, each 4 inches by 3 inches, and trussed and strutted where necessary.

All floors of apartments on chamber-floor to be deafened as a pre-

ventive of sound, and of the spreading of fire. To have narrow boards $\frac{3}{4}$ inch thick, laid on fillets $1\frac{1}{4}$ inch by $\frac{3}{4}$ inch, firmly nailed to the sides of joists.

All walls having bond timbers to have battens or wall straps, $1\frac{1}{4}$ inch by 1 inch, placed 12 inches apart, and firmly nailed to the bond timbers.

All the apartments having joisting to be laid with straight joint batten flooring, 1 inch thick, having tongued headings and borders for hearths.

Wood bricks to be built into all places where required for timber finishing.

All angles in building to be provided with one-inch staff beads. Fix proper grounds for skirting, and round all windows for finishings.

The stairs to have treads and risers of one-inch deal, and to have wall and outside stringers housed for ends of steps, to have framed and turned newals, and provided with one-inch square timber balusters and moulded oak handrail: each step to have a plain cut bracket at the end, and circular where required, metred to riser; first step to have proper curtail.

Frames for outside doors to be 4 inches by $2\frac{1}{2}$ inches; all the other doors to have $1\frac{1}{2}$-inch rabbeted casings the full thickness of wall, to receive plaster.

All windows to have deal-cased frames and oak sunk sills; to have sashes 2 inches thick, double hung with brass-faced box pulleys, patent line, and iron weights.

Entrance doors to be framed, 2 inches thick, panelled, and moulded outside, and bead and flush inside. Back outside doors to be framed, $1\frac{3}{4}$ inch thick, with stuck mouldings inside, and bead and flush outside.

The privy and cellar doors to be of one-inch beaded deal, with cross bars and back.

Principal room doors to be framed, $1\frac{3}{4}$ inch thick, panelled, with raised planted mouldings on both sides; all other doors to be $1\frac{1}{2}$ inch thick, framed and panelled with stuck mouldings.

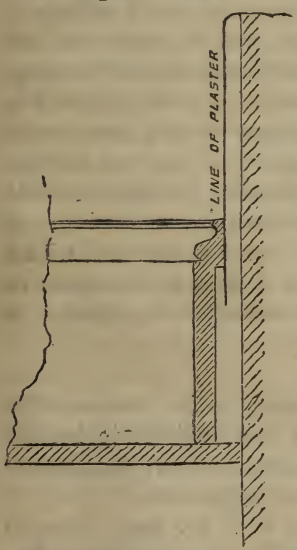
Principal rooms to have shutters $1\frac{1}{4}$ inch thick, panelled and moulded similar to the doors, having one-inch back flaps.

The breasts of all the windows to be provided with inch-thick framed lining, moulded similar to shutters.

Doors and windows of principal rooms to be provided with moulded

architreeves, 6 inches broad single fascied; and those in bed-rooms and other apartments to have plain facings, $4\frac{1}{2}$ inches broad, 1 inch thick, moulded on both edges.

Principal rooms to have moulded base plate, 9 inches broad, 1 inch thick, having $2\frac{1}{2}$-inch moulding. All other apartments to have moulded skirting-plate, 6 inches broad, 1 inch thick.



Fit up water-closets with one-inch deal seats and risers, clamped flaps and frames having all requisite bearers and fittings, and line wall, 2 feet above seat, with $\frac{5}{8}$-inch beaded lining; provide $\frac{3}{4}$-inch deal casings for pipes, with rebated and beaded grounds. Each water-closet to be provided with a cistern to contain eighty gallons, made of $1\frac{1}{2}$ inch deal dovetailed, and put together at the joints with white lead.

Provide the kitchens and pantries, and all presses or cupboards, with inch-thick deal shelving, supported on proper brackets where necessary.

Provide the kitchens with 40 feet linial of utensil belting, 4 inches broad, firmly fixed to walls, with brass hooks for ditto.

Fit up in kitchen a dresser, with two drawers, shelves, pot boards, and bearers.

Fix up in scullery $1\frac{1}{2}$-inch clamped dresser, top hung with hinges having moveable brackets underneath.

The whole of the joisting and roofing, and all timber exposed to

the weather, to be of the best Quebec red pine, and all inferior finishing to be of the best American pine. All the timber to be properly seasoned before being used, and to be of the best description, free from sapwood, shakes, large knots, or any other blemish.

SLATER:—All the roofs to be covered with the best full-sized slates, having 3 inches of cover at the eaves, and diminishing to 2 inches at the ridges, and well bonded, fixed on the laths with copper nails, and all rendered with good lime-and-hair-mortar. All rabbets for slates to be carefully pointed with mastic. All eaves to be double slated. The whole roofs when finished to be complete and water-tight.

PLASTERER:—To lath lay float and set ceilings in principal rooms. To lath float and stucco quarter partitions. To render float and stucco walls in principal rooms, and to run plain cornices round angles of ceiling 12 inches girth. To lay float and set all ceilings in chamber-floor, staircase, lobbies, kitchens, &c., and to render float and stucco walls in all these apartments, run small cornices round landings of stairs and ceilings of bed-rooms and passages, and cut all quirks to angle beads. All walls behind timber linings to have one coat of plaster. The deafening for floors to be composed of lime and smithy-ashes, laid to the thickness of 2 inches, and before the floors are laid to be floated over with thin plaster to fill up cracks.

The plaster to be composed of lime and clean sharp sand, with a proper proportion of fresh hair, and all to be of the best description as to materials and workmanship, and to be free of cracks, blisters, or any blemish, when finished.

PLUMBER:—All ridges, hips, and vallies, to be covered with milled lead, weighing 6 lbs. per superficial foot; gutters to be laid with 7 lbs. lead, and turned 6 inches up under the slates; flushings of 5 lbs. lead; rose head and shoes over cesspool in gutters.

Eaves gutters to be $4\frac{1}{2}$ inches diameter, of 7 lbs. lead, hung on malleable iron straps, firmly nailed to the roofing, and placed 30 inches apart, the straps to be dipped in pitch and tar when hot. The rain-water pipes from gutters to drain will be $3\frac{1}{2}$ inches diameter, of 5 lbs. lead, with a 9-feet length of cast-iron next the ground, and all to have large-size moulded pipe-heads. Line all cisterns with 6 lbs. milled lead, and provide 2-inch-washer and waste, with ball-cock and boss, and $\frac{3}{4}$-inch supply-pipe. Provide all sinks with $\frac{3}{4}$-inch brass supply-

cock, 2-inch waste pipes, copper grate bell and trap, and ¾-inch supply-pipes.

Provide a 3-inch brass barrel force-pump for each scullery, to supply cistern of water-closets, having 1½-inch rising main. Provide water-closets with the best patent pan apparatus, with blue and white basin, brass pull ball, and lever cranks. Cistern valve, S trap and soil-pipe complete to enter drain. Service pipes to be ¾ inch diameter.

GLAZIER:—All the window sashes to be glazed with the best Newcastle crown glass, well and neatly puttied. All sashes to be primed with one coat of oil paint before being glazed.

IRONMONGERY:—The entrance doors to be hung with 6-inch butt hinges, and to have 9-inch iron rimmed locks, with brass mountings. Back doors to be hung with 6-inch butt hinges, having 6-inch iron rim locks with brass knobs.

Principal room doors to be hung with 5-inch butt hinges, having 6-inch mortice locks with brass mountings. Bed-room doors to be hung with 4-inch hinges, and to have 6-inch iron rimmed locks. All press doors will be provided with good press locks and suitable hinges. All doors in kitchen apartments will be hung with 4-inch butt hinges, and to have spring latches. All water-closet doors to have spring mortice latches. Window shutters to be hung with 2½-inch butt hinges, and provided with brass shutter knobs, back flaps hung with back flap hinges.

Windows in principal rooms to have brass spring sash fasteners and sash lifters; all other windows to have screw fasteners. The whole of the ironmongery to be of the best description, and all hinges to be double jointed.

The stone stairs to have neat cast-iron balusters, batted and run with lead into the ends of steps.

Gratings for openings below floors and in pantries for ventilation.

Provide latch spring shutter bars to all windows on ground floor.

PAINTER:—Paint all the wood-work four times in good oil colour. Paint front entrance doors grained wainscot, and twice varnished.

APPENDIX.

LABOURERS' COTTAGES.

Since this work was first compiled, so much attention has been devoted to the improvement of the homes of the labouring classes, that this little treatise would be incomplete, and behind the spirit of the times, if it did not enter more largely into the subject of labourers' cottages. Allusion has been made, in the first portion, to the exertions of that large-minded philanthropist, John Howard, to ameliorate the condition of the houses of the rural poor; and also to the princely examples of the Duke of Bedford, and other noblemen, in the same direction. It is gratifying to record that day by day the workers in this noble cause multiply, and that their labours are gradually producing the most satisfactory results. In cities and towns, where attention has been directed to the sanitary improvement thereof, the annual returns of the Registrar General show abundant evidence of the clearest character, that disease and death decrease to a very large extent. Medical statistics have been published which fully prove that, in the most favourable instances, death annually numbers amongst its victims a large proportion who die of preventible diseases, *i. e.*, diseases arising from over crowding, bad drainage, or by the air which we breathe being rendered impure, and, consequently, fatally poisonous to health, &c. Most probably in the minds of those who peruse this little work the thought will arise, "This is all very true as affecting towns, and other over-crowded places; but of course death in rural districts cannot be avoided by any precautions in the situation and arrangement of habitations, as there is abundance of fresh air and ventilation, and the inhabitants lead mainly healthy out-of-door lives." To prove how fallacious such a belief is, we quote from a pamphlet by Dr. Acland, Regius Professor of Medicine in the University of Oxford, entitled, "Fever in Agricultural Districts; being a Report on Cases of Fever occurring in the Parish of Great Horwood, in the County of Buckingham, 1858":—

"The purpose of my visit was to gather the particulars of a fever

which has been endemic in the parish since Michaelmas, 1857. Accordingly, my attention has been especially directed, 1stly, to the nature; 2ndly, the cause; 3rdly, the treatment; and 4thly, to the mode of prevention of the disease.

"In reporting to you the conclusions at which I have arrived, I take leave to do so at the greater length, because the danger is not only considerable, but deeply rooted in this district; and because, did I answer you briefly, it might be supposed that I thought lightly of the case, because the mortality is numerically small. How grave the evil is may best be appreciated by a comparison, even if in some respects it be inapt. An endemic affecting a similar proportion of the population of London would attack, in nine months, more than a quarter of a million of persons of all ages; above fifty thousand would die of the fever alone, while the deaths during the period from other causes would not be diminished. Further, you will perceive that the remarks which will be made on the population and its circumstances are applicable to many districts in this and other counties; and that the instance of Great Horwood is therefore instructive to many as an example of the risk in which some people live, who are apparently leading healthy out-of-door lives."

The description of the healthy situation is most particularly noteworthy:—

"The part of the parish of Great Horwood in which the village is situate occupies a ridge of the oolite which runs down from Whaddon Chase in a westerly direction, is bounded on either side by a moderate valley, and terminates by a gentle fall a mile to the south-west of the township.

"In each valley a small rivulet runs, generally from east to west; the two rivulets unite at the base of the slope just named, and the joint stream enters the Ouse between Padbury and Buckingham.

"There is, therefore, a natural fall to the north, the south, and the west. The parish is pleasantly but not excessively wooded, grows splendid corn, and has meadows of rich pasture on undulating slopes.

"The parish has, within the last few years, greatly improved. Industry and neatness are the rule in the parish rather than the exception; and although, as will be presently seen, there is yet much to be done in reconstructing on a better plan the poorer class of tenements, yet steady progress has been making for some time past by the whole population."

The causes of the fearful mortality for the most part are attributed by Dr. Acland to "destitution, mental depression, putrescent

organic remains, over-crowding, deficient ventilation, contagion. These appear to act with the more intensity in proportion as they combine together."

It may answer a good end to quote one of the Doctor's notes in respect to houses in which the endemic was virulent :—

"It is quite otherwise with the house where the next set of cases occurred. That house was one of the worst in the parish; it was an underlet tenement, and in some respects in a shocking condition. Some of the family slept in an upper room, large enough indeed, but dirty. The floor is old and bad; the ceiling below is not plastered; the area beneath this floor was nearly a foot deep in black, stagnant water, into which from without filth oozed. All who slept in the room over this swamp were taken ill, and three of the family died."

Further on in this interesting pamphlet, Dr. Acland enters into a summary of the evils of the present condition of the labourers' cottages, and the remedies which he proposes. These are so valuable, that, although merely compiled for a professional report for a special purpose, they will be found most admirably adapted for general application. To promote the most urgent social improvement of the day, this portion of the Doctor's pamphlet is published in full, as these observations from so high an authority must have the greatest weight, and they are seriously deserving the attention of those who, not having considered the subject, believe that in the open country any hut or hovel is sufficient for the housing of the poor. Those persons holding such belief, or whose minds are so falsely impressed, the study of the concluding paragraphs of the Doctor's report will undeceive, and will show that if they have no higher aim than warding off disease and death from themselves and families, they are vitally interested in the improvement of their own and labourers' dwellings. Dr. Acland thus concludes his report—

"SUMMARY OF EVILS.

"It remains only now to sum up into a few words the conditions which appear to have favoured the continuance of the disease during the last nine months. Reverting to the modes of origin of fever as stated above, viz., destitution, bodily and mental depression, contagion, over-crowded dwellings, putrescent animal and vegetable matter, and an insufficient supply of fresh air, or, as it is called, bad ventilation, we must attribute in various degrees the persistence of the affection to the last four, and especially to bad ventilation. The evil is most grievous in the sleeping rooms. 'We

can do no more,' said one admirable woman, 'than keep clean that which we have. We cannot get our landlord to give us more air, or make the windows we have to open. "Women," he said "are best shut up."' Some of the small cottages at Wigwell are models of personal cleanliness and of neatness on the part of the inmates. The fault is not in them, but in their tenements. So offensive do the bed-rooms of some become in the rooms where the windows are near the floor, that one said to me, 'I often awake in the night stifled, and me and my husband go and sit at the window.'

"Too much stress cannot be laid on this. It is an evil the inmates cannot, with their present education and notions, rectify. It would seem very easy, by borrowing a tool or two, to make, at the cost of a little labour and wit, an additional window in a roof; but 'it is the landlord's place' to do it. He does not know of the necessity, or *has not the means*, or doubts the soundness of what he considers sanitary innovations. And as for the father, he comes home tired. From day to day the old small casements remain; no better are substituted, and none are added.

"To this I must only append the oft-repeated caution against accumulations of muck, filth, and piggeries close to human dwellings. The great difficulty of the case must be admitted. Custom, convenience, poverty, want of time, family cares, close living, combine against the formation of the energetic moral habit which leads to the most healthful state of body and mind. With many, therefore, the difficulties of living are barely surmounted; complete mastery of their circumstances is seldom attained.

"REMEDIES PROPOSED.

"From the statement of the causes which has been made, the remedies become self-evident.

"In all cases of Endemic disease, there are two main objects:—1st, to treat the sick; and, 2ndly, to check the formation of new cases of illness.

"1. Under the first head, the treatment of the sick, you have no great difficulty. With an attentive and zealous medical officer, who has not spared himself, the poor have the advice they stand in need of. But for placing them favourably for following our advice, two things are necessary: 1st, a superintending nurse or nurses, as the numbers may require; 2ndly, either the removal of the sick person to an airy apartment, or of the rest of the family to another house.

"You have no difficulty about a nurse, as an old Crimean nurse is

already gone to you, and more can be supplied from hence, or from elsewhere, should you need them: and for the second recommendation, a barn might be borrowed; at this time of the year it would furnish all the comfort you need. At all events, it is certain that as many of the roof attics at Nash-End, Singleborough-End, and Wigwell now are, a due supply of air, without an alteration in the windows, is impossible.

"The ministrations of the esteemed rector, to whose devotedness the parish is largely indebted, will supply his flock with confidence and cheerfulness; these will conduce to that vigorous state which is calculated as well to resist the infection as to battle with the disease.

"2. With respect to the secondary measures, those for checking the disease, they also have been implied, and may be briefly summed up.

"The removal of sewage from an agricultural village is attended with particular financial difficulty. Your legal adviser will, however, best explain the methods and the powers by which funds may be raised under the existing Health Acts. Horwood has remarkable facilities for systematic drainage. These I have pointed out above. The cost, therefore, would be less, and the result much better in many villages.

"If this is not to be done, the next step is to take measures for a methodical removal of the 'soil,' and for a cleanly manner of keeping it till it shall be removed. The Chinese are great adepts at ensuring the removal of human ordure; and it was carried to some perfection in France.* I have no doubt that by energy and attention on the part of an inspector, or with a small subscription, measures might be taken to ensure the regular cartage of all refuse that can be useful in agriculture to the allotments or grounds where it is needed, with advantage to the cultivator as well as the inmates. In truth, as is well known, in some places these heaps are purchased. Any way, the object to be aimed at is a system of complete removal at short intervals.

"When the exterior of the labourers' dwellings has been so provided for, the next desideratum is a dwelling which will be healthy if kept with care. A neat cottage has been built near Wigwell, and is beautifully kept. But it is nearly on the model of the old traditional kind; being so, clearly, from want of knowledge, and not of intention. There is no back door: the rooms are somewhat higher, but the bedroom windows are far too small, ill placed, and insufficient, and the

* "See Appendix to Memoir on the Cholera at Oxford. (London and Oxford: Parker. 1856.)

ceiling under the collar should be pierced with a ventilating trap-door.

"A MODEL COTTAGE IS REQUIRED.

"It is of the utmost consequence, in a sanitary point of view, that in every district there should exist a good cottage built at *the cheapest rate*, to serve as a model to small capitalists and tradesmen who are willing to invest in this kind of property, and as a pattern to the labourers of the kind of cottage they ought to have. I take leave, therefore, to add, in a few propositions, the essentials for a healthy cottage. The grounds of the several recommendations are generally very obvious, and I should fear to trespass on your patience if I were to do more than enumerate them.

"1. Detached or double cottages are preferable to rows. Double cottages are perhaps the best of the three.

"2. The angles, not the sides of the building, should be placed to the cardinal points of the compass. They should stand *in* their garden-plot; that is, a little way back from their front boundary.

"3. The garden should, if practicable, contain from a sixth to a quarter of an acre. The privy should be at the extreme end, with the pigstye, if there be one. But as it is very doubtful whether a pig is a real advantage to a small family living on small means, and as it is certain that a pigstye is in itself an evil, pigs are to be tolerated, not to be encouraged.

"4. A drain from the back door to the privy should carry surface drainage and house slops to the privy; and thence, wherever practicable, another drain should lead to a tank for distribution by the farmers to meadow or other land. The cesspool should be a closed one, if a cesspool is necessarily employed, and agreements should be made for periodically removing its contents.

"5. Tiles or slates, not thatch, to be used.

"6. A back as well as a front door: windows on both sides of the tenement, if in a row: or on three sides, if in a double cottage. A window in the pantry. Both sashes to open, where sashes are used; both casements, where there are double casements.

"7. The day-room to have in its chimney an Arnott's valve or the better arrangement of an air-tube or separate flue. The floor to be made with a boarded centre, and hard flags or tile border, set in concrete. The floors to be raised six inches at least above the outer road. The back room to have a fireplace, with boiler attached, and a well-trapped sink.

"8. Three bedrooms: for parents, boys, and girls. Height of rooms to be eight feet: the top of the windows to reach the ceiling. A fireplace to be in one room at least, a ventilating tube in the other two.

"9. The front room and bedrooms to be approached from a porch: the staircase may be open to the room, or closed.

"10. Where rows of houses exist, a washhouse in common to all the houses should be contrived in the garden. It may be next a row of houses and tool-houses, and have a common pump adjoining. Its drain to go to the privy.*

"11. The privy in every case to be removed as far as possible from the water supply.

"SUMMARY OF REMEDIES.

24. In conclusion, the following recapitulation and summary are added of remedies suited to your present emergency.

"I. IMMEDIATE MEASURES.

"TREATMENT OF SICK.

"1. Removal of early cases to more airy apartments: a barn may easily be made more comfortable than some of the rooms, and more healthy to the wife or attendants.

"2. When the removal of sick cannot be effected, removal of the other inmates, except those required for nursing.

"3. Immediate washing of linen, by a paid washerwoman, the clothes being boiled in a copper.

"4. A competent superintending nurse to go round to the cases

* "It would be needless to go into further detail: ample information may be obtained, as well as specifications of small dwellings, from the Sanitary Report, 1842; from the admirable volume, 'The Dwellings of the Labouring Classes,' by Roberts; and from the Journals of the Royal Agricultural Society, and also of the Bath and West of England Agricultural Society, for the year 1856 (Ridgway, London); in these valuable periodicals, copious details are given in a prize essay by Mr. Isaacs of Bath.

"There is reason to believe, as I have said, that New College will shortly erect some excellent cottages in Great Horwood; some model cottages have been long desired in Oxford; see my 'Memoir on Cholera in Oxford.' On almost every gentleman's estate there are examples: on Sir H. Verney's, or, further off, at Windsor, on the Bedford estates, the Pusey estate, Sir Robert Throckmorton's, Lord Radnor's, &c.; but I do not insist on these, because my object is to aid small capitalists and small builders in the way of making the cottages which they build as free from fault as possible, and at the same time of making them serve as investments as well (if this word may be used) as they do now.

daily, to see that the advice of the medical officer is carried out, and to report to him where, why, and in what there is difficulty in obeying him.

"MANAGEMENT OF DWELLINGS AND INSPECTION OF NUISANCES.

"1. To recommend to every house where the disease has existed systematic cleaning and lime-washing. When the inhabitants have not the means, to do this for them without charge; urging upon them the burning of accumulated rags and useless stores, which will in some houses be found.

"2. To remedy, as far as possible, every privy in a dirty condition, by burying its soil with lime; and when it adjoins the house, to remove it to a greater distance: to clear and trap existing drains, especially at the cottage doors.

"3. To examine the ground near the bedroom windows, and to remove any putrescent matter.

"4. To open small dormers near the ceiling of such bedrooms as are in the roof, in close and small cottages; and to open trap-doors in the bed-room ceilings which are applied at the level of the collar in the same cottages.

"II. PROSPECTIVE OR PREVENTIVE MEASURES.

"DRAINAGE.

"To consider seriously the feasibility of a systematic drainage of the parish in connection with the two natural streams, and the formation of sewage-tanks on those streams for the adjoining lands, such tanks to be placed at a distance from houses: to drain thereby or fill up stagnant ponds and ditches near houses.

"HOUSES.

"1. To improve permanently the ventilation of the existing rooms, by opening and enlarging casements, adding Arnott's valves, or ventilating tubes; to remove pigstyes and privies as far as possible, especially from the bedrooms; to emend the privy arrangements, where possible, on Isaac's method. (See 'Royal Agricultural Journal,' 1856.)

"2. To promote the erection of cottages of greater height, and constructed on the principles above described.

"It is not consistent with observed facts here or elsewhere to conclude that fever necessarily accompanies foul drains, or even overcrowded, unclean, and unventilated dwellings; but for the practical

purpose of caution, and for the inculcation of a just dread of these conditions, it is equally cogent if we are obliged to believe that fever may originate at any time in such circumstances; that they are exceedingly favourable to its development; that where fever has once entered, its ravages may continue for many months; and, which is most alarming, that, when it has entered a district, the danger is no longer confined to the unclean and the careless. In the great epidemics of Scotland and Ireland this has been abundantly and repeatedly proved.

"It is my duty further to remind you that there is no doubt that the disease may be carried, and is habitually carried, from place to place by persons moving to and fro; by residents; by vagrants; and that when so imported, it establishes a fresh centre of disease. This has actually happened, as I have before stated, at Winslow. That centre, then, begins afresh. If it happen to light on a dwelling not favourable for further development, it is well. If it light on a house where all is ready for the formation of the poison, the whole family may be consumed, and a newer and more potent ferment is established for that neighbourhood.

"They who know and believe these things are separated by a wide gulf from those who do not know or who do not believe them. They who do not know or believe, or who, knowing and believing, persuade themselves that themselves will be exempt, turn aside from the physician who strives to PREVENT, as from a visionary, and so wait the time when the only thing left is to cure what might have never occurred, and is then perhaps incurable."

Numerous other examples could be cited of endemics in rural districts, equally fatal in the result as that mentioned of Great Horwood; but it is assumed that sufficient has been said to show that the like causes affecting health produce the like effects in town or country. No doubt that the fresh air of the country is a powerful antidote to the poisons which are inhaled through the vitiated atmosphere of houses; but still, on the other hand, the woful inattention to sanitary measures which generally prevails in rural districts renders them often more unhealthy than towns, which have been compelled, in self-defence, to take sanitary precautions.

Perhaps of all the causes injurious to health, that of deficient ventilation, generally caused by over-crowding, is the most fatal. The military authorities have been lately startled by statistics, which show that the deaths in the Foot Guards have been, in proportion, nearly three times as numerous as those in the Metropolitan Police, or the

general average of England. Now, when we consider that all soldiers entering the army undergo medical examination, or, to speak in the language of assurance companies, are picked lives, the general regularity of their living, and goodness of their food, this return is most remarkable. Every conceivable reason for this excessive mortality has been discussed, but the inevitable conclusion which has been arrived at, and is now acknowledged, is, that such mortality is mainly the result of over-crowding.

Dr. Neil Arnott, before the Health of Towns Commission, tells an instructive story about some monkeys in the Zoological Gardens—

"A house," he says, "was built to insure to those natives of a warmer climate all attainable comfort and safety. For warming it, two ordinary drawing-room grates were put in as close to the floor as possible, and with low chimney openings, that the heated air in the room should not escape by the chimney, while the windows and other openings in the walls above were made as close as possible. Additional warm air was admitted through openings in the floor from around hot-water pipes placed beneath it. For ventilation in cold weather, openings were made in the skirting of the room close to the floor, with the erroneous idea that the carbonic acid produced in the respiration of the animals, being heavier than the other air in the room, would separate from this and escape below. When all this was done, about sixty healthy monkeys, many of which had already borne several winters in England, were put into the room. A month afterwards more than fifty of them were dead, and the few remaining ones were dying.

"It was only necessary to open, in the winter, part of the ventillating apertures near the ceiling, which had been prepared for the summer, and the room became at once salubrious."

Enough has been said, as far as our limits will allow, on the sanitary consequences of over-crowding. We cannot pass from this subject without alluding to the moral results. Over-crowding is carried to such an excess that, in some cases, the father, mother, grown-up sons and daughters occupy one apartment; but frequently young men and women of the same family, approaching puberty, share the same chamber. Such a condition of living, in a social sense, is both disgraceful and dangerous—disgraceful to a Christian community, and dangerous to the state, as increasing crime, disease, and pauperism. How can we expect women so reared to be pure? How can we entrust to them the rearing of families in their turn?

This consequence of over-crowding is the most baleful. *Mens sana*

in corpore sano should be the motto of every state; but its first duty is to maintain the healthy moral condition of its people. Attention has at length been directed, by numerous philanthropists, to the consequences of our labourers' children being bred in homes where health is perhaps the exception, and decency nearly impossible, and where the fathers and mothers, despairing of comfort, or bettering their condition, become dissipated, reckless, or apathetic. It is as much to the interest of the landholder and occupier to have good labourers as it is for the landholder to have good tenants. Good farm-buildings are now indispensable to secure good tenants for farms: convenient and healthy cottages will secure good labourers. Now, it is evident that the better the labourer the greater the profit to the farmer, and the greater the profit to the farmer the greater the increase of the value of the land, and the greater the value of the land the richer the State. Again, the more squalid or wretched the labourer, the greater the burdens that press upon the State, the greater the disease and crime, and the greater the poor rates, the county rates and taxation. All classes of the community are therefore vitally and pecuniarily interested in the well-being of the poor; and the greatest want of the present day is healthy, commodious homes.

In the first portion of this work, plans are given of convenient labourers' cottages, affording excellent accommodation, at estimates varying from £125 to £150 per cottage. Several architects have also given this subject a great deal of attention and care, and "The Dwellings of the Labouring Classes," by Roberts, is deserving of the most extensive perusal and study. The Society of Arts, the Royal Agricultural Society, and many other agricultural societies, have also with great wisdom offered prizes for plans containing the greatest accommodation at the lowest possible cost; and the plans which have been awarded are worthy of the greatest attention. As the cost, however, of erecting houses on many of these plans exceeds that amount for which the ordinary rent paid by labourers for cottages would be a fair return, we have searched further, and been attracted by the prospectus and plans of "The Cottage Improvement Society," * and we think that we shall best serve the cause we have in hand by publishing their plans with specifications and estimates. No doubt the rooms are very small, but the problem of erecting a cottage containing four rooms for 75 guineas is apparently solved, and it is to be borne in mind that this solution is not on paper only, but is

* The Cottage Improvement Society, 18, Adam Street, Strand, London. President—Marquis Camden. Chairman—Earl of Darnley.

proved by actual experiment. We, in conclusion, give extracts from the following letters :—

From Mr. W. G. HAPERSHON, Architect, Bloomsbury Square, to the Secretary.

SIR,—I have carried out for Sir Culling Eardly two cottages, on his estate at Erith, according in *all respects* to the published plans, and they give me great satisfaction. They will be built *within* the cost named (155 guineas), and will, so far as I am able to judge, answer their end perfectly.

From the builders Messrs. SEAGRAVE and BLOFIELD, High Holborn, to the Council of the Cottage Improvement Society.

Having erected several pairs of cottages according to the Society's plans, we are willing to carry out the same on the Society's estimate to any extent, where the bricks can be obtained at 28s. per thousand.

From Messrs. RAWLINGS and SQUAREY, Architects, Salisbury, Wilts, to the Secretary.

SIR,—We have completed one pair of cottages on the plan No. 2 of the Cottage Improvement Society. The specifications are adhered to in all important features, and are modified merely in respect of the fittings to the kitchen. The total expenditure was £154 19s. 11½d., exclusive of carriage.

From THOMAS KIBBLE, Esq., Hadlow, Kent, to the Secretary.

SIR,—Referring to your inquiries as to the construction of model cottages, the pair which Mr. George Punnett erected for me were on the first plan of the Society, and cost the sum of £168.

NOTE.—To prevent over-crowding, it is necessary to observe that the cubic contents of these rooms being small, in no case are the largest fitted for the occupancy of more than two adults in each large room; and for such occupation there should be ample openings for ventilation.

PLANS AND SPECIFICATION FOR ONE PAIR OF COTTAGES AS PER PLAN NO. I. OF "THE COTTAGE IMPROVEMENT SOCIETY."

Plates 22, 23, 24, 25, 26, 27, and 28. This cottage contains living room, 11 feet 4 inches by 9 feet 4 inches; boys' room, 11 feet 4 inches by 7 feet 10 inches; parents' bed-room, 11 feet 4 inches by 9 feet 4 inches; girls' room, 11 feet 4 inches by 7 feet 10 inches; store in roof; closet, water-closet, and porch. Estimated outlay, 150 guineas per pair.

SPECIFICATION.

BRICKLAYER.—To dig out foundation, and build with good clamp bricks, 9-inch work, external walls; the internal and water-closets, $4\frac{1}{2}$ inches; the bricks to be bedded in mortar, composed of three parts sand and one part stone lime; two courses of slate, bedded in cement, to be laid below the floor line; the water-closets to be paved $4\frac{1}{2}$-inch brickwork for the ground joists.

SLATER.—The roofs of the cottages and water-closets to be slated with countess slates, or plain tiles properly capped and nailed, pointed with hair mortar, and the ridges to be saddled with coloured ridge tiles.

CARPENTER AND JOINER.—To provide and fix roofs of cottages and water-closets, the joists not to be more than $12\frac{1}{2}$ inches apart. *Sizes of timber:* bond, 4 inches by $2\frac{1}{2}$ inches; ground joists, 4 inches by 2 inches; upper floor joists, 7 inches by 2 inches; ceiling joists, 3 inches by 2 inches; rafters, 4 inches by 2 inches; purlins, 4 inches by 3 inches; struts, 4 inches by 3 inches; wall plates, 4 inches by 3 inches; pitch boards, 6 inches by $1\frac{1}{4}$ inch; lintels, 4 inches by 4 inches; outside door frames, 3 inches by 4 inches; slate battens, $2\frac{1}{4}$ inches by $\frac{3}{4}$ inch. To provide and lay $\frac{3}{4}$-inch floor boards to house; to provide and fix $\frac{3}{4}$-inch skirting, $4\frac{1}{2}$ inches wide; to provide all inside $1\frac{1}{4}$-inch doors with linings, fastenings, butts, &c., complete; to provide and fix outside doors to house $1\frac{1}{2}$-inch bead and butt, with frames, locks, &c., complete; to provide, fix, and hang $1\frac{3}{4}$-inch casements in solid frames, with casement stays and bolts complete; to provide and fix 1-inch chimney pieces to bed-rooms; to provide and fix $1\frac{1}{4}$-inch chimney pieces to ground floor rooms; to provide and fix seats, risers, &c., to water-closets complete; to provide and fix $\frac{3}{4}$-inch ledge doors and frames to water-closets complete; to provide and fix stairs to cottages, 1-inch string boards, 1-inch treads, and $\frac{3}{4}$-inch risers.

PLASTERER.—To lath and plaster two coats, and set ceilings to house, excepting living room; to lath and plaster two coats, and set walls of house.

GLAZIER.—The whole of the glazing to be done with second crown glass, bedded in putty.

PAINTER.—All inside work to be stained and varnished. Outside work to be grained and varnished.

SMITH.—To provide and fix all chimney bars to fire places, 4½-inch gutter to eaves, 2½-inch pipe to house, gutter to water-closets.

MASON.—To provide and fix stone steps to outside doors, if required; to provide and fix sink stones to cottages, and tooled York cills to windows.

PLUMBER.—To provide and fix inch waste pipes to sinks.

The whole to be done according to plan.

PLAN NO. II. OF "THE COTTAGE IMPROVEMENT SOCIETY."

Plates 29, 30, and 31. This cottage contains somewhat similar accommodation to the one preceding. Estimate, 160 guineas per pair.

This plan has received the verbal approval of the Enclosure Commissioners of England and Wales, and the possessors of entailed estates may, under the provisions of the Drainage and Improvement Act, obtain advances for the erection of labourers' cottages on this plan, thus charging the cost of repayment upon the inheritance. To these plans is adapted a very economical system of oven and kitchen grate, of which a model is exhibited at the Society's office.

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